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ECONOMIC AND SOCIAL RESEARCH

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XIII

COMPARATIVE PRODUCTIVITY IN BRITISH AND AMERICAN INDUSTRY

THE NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH

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COMPARATIVE PRODUCTIVITY IN BRITISH AND AMERICAN INDUSTRY

by

L. ROSTAS

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FOREWORD

THE first lesson in the elements of political economy taught at the beginning of the century was that Production consisted in the creation, not of material objects, but of utilities It was a natural step from this to the study of value as a measure of utility, and of the market as a mechanism for relating resources to wants In recent years economists have been more concerned with the deficiencies of prices as an indication of utility and with the imperfections of markets as a means of relating resources to wants One result has been a new interest in objective measures of economic activities, among which measures of the physical volume of production are among the most important. This interest has been intensified by the condition in which most countries find themselves after war, a condition of almost universal shortages, which has forced attention back to the elementary dependence of economic well-being on physical output Once attention is turned this way, the differences between different countries are noticed and call for explanation. Dr Rostas had already published the first important essay during the war in England on this subject

The chief single source of information on physical productivity is in most countries the Census of Production Dr Rostas was engaged on an intensive study of the English census for another purpose when his interest was drawn to international comparisons The wealth of American statistics of production made comparisons with that country the obvious starting-point of any investigation. The interest which his article excited, and equally the criticisms it attracted, encouraged him to extend his investigation further The National Institute was impressed by its importance, and offered such encouragement and facilities as were in its power Not only were the international comparisons interesting and important in themselves, but they promised to throw a great deal of light on the changing structure of industry in this country, the subject on which most of the studies being carried out under the Institute's auspices centred

Dr Rostas has carried his investigation far beyond the limits of his pioneer article His main object has been to collect and present the relevant data, but this has involved him in a criticism of the data—their reliability, their adequacy, their significance, and the limits to their legitimate use. His claims are modest, he offers his work as a preliminary survey and invites criticism and further work. But already he has performed a great service to his fellow-students, the mass of material he has made available is something quite new in this country; he gives his sources and calculations so that others can work over his material, and he has thus provided the basis for a new examination of the questions raised by differences in productivity between different countries

There will, I think, be general agreement that the subject deserved study, and that the scientific detachment with which Dr Rostas has pursued his study and the objectivity with which he has presented his results made it a fortunate choice In a subject which bears so closely on many issues of current controversy, there is always the danger that the qualifications and

that his data will be used to support conclusions which he himself does not draw from them, and that inferences which he does not make will be attributed to him This is a risk which the pioneer must face, and Dr Rostas is not to blame if, in spite of all his care, such misuse is made of his work What can be done by careful statement and repeated caution to prevent such misinterpretation and misrepresentation, he has done, but it may be well to emphasize that his book is primarily addressed to the technical reader, and is offered, not as ammunition for the current polemics on industrial policy, but as a contribution to a little-worked but essential field of scientific investigation.

One of the most interesting problems that Dr. Rostas examines in this exploratory comparison between countries is the relation between productivity in particular branches of economic life and the productivity of a country's economy as a whole. Earlier economists had concentrated on the latter, and had related a country's productivity to the ratio of natural resources and capital to population, recent controversial writing has concentrated on the former and contrasted British manufacturing industry unfavourably with American manufacturing industry. Dr Rostas's concluding chapter points the way to a much more scientific and illuminating approach to such international comparisons. The criticism which the person engaged in industry always makes of such comparisons is that they do not take account, or take inadequate account, of differences in type and quality of product Dr. Rostas is fully aware of this difficulty, he has been at great pains to meet it; and he warns his readers against accepting as final the figures on which he has lavished his care, until fuller study than one individual can give is given to such variations concealed under an identical description

It may be emphasized in conclusion that, although he has brought together so much material relevant to it, Dr Rostas is not offering a general description and analysis of the economy of this country and the countries with which he compares it To such a general analysis the elementary principle referred to in the first sentence of this note would be relevant. The same material good, whether product ready for consumption or instrument available for production, will have varying degrees of utility at different times and in different countries. The industrial practice of the United States of America, which could accommodate the whole population of the world and still exhibit a density of population no greater than that of the United Kingdom, is likely to be different from that of the latter country On the other hand it would be dangerous to jump to the conclusion that the United Kingdom would be enriched by the loss of a large part of its population. Dr Rostas is not concerned with these broader questions, but his careful and comprehensive examination of a single element in them will elucidate them, and should induce caution in approaching them

Henry Clay
Chairman of the Council
National Institute of Economic and Social Research

November 1948

PREFACE

THIS study carries one stage further investigations I have previously made into international comparisons of productivity The first results of these investigations were published in *The Economic Journal* for April 1943. The present study presents revised data on comparisons of productivity in the manufacturing industry of the United Kingdom and the United States and it also enlarges and develops the subject further It discusses the meaning and significance of comparisons of output per worker or per man-hour, and sets out some of the alternative methods by which they can be made. In addition to a comparison of relative productivity in manufacturing industry, a comparison of relative productivity in the non-manufacturing industries of the two countries has also been attempted, making possible the reconciliation of productivity comparisons with real income comparisons. A summary of available information on long-term changes in output per worker or per man-hour in the manufacturing industry of the United Kingdom and the United States is also included Lastly I have discussed, in a preliminary way, the factors affecting relative productivity.

These results are not to be regarded as final On the contrary I feel that we are still at the beginning of enquiry into the fascinating subject of relative productivity, and I hope that this study will stimulate further research. It shows the limitations on how far we can get *on the basis of available data and information* towards knowing what our relative productivity is *vis-à-vis* other countries, and it shows as well the limitations on our attempts to account for the differences It is to be hoped that, once more detailed and more appropriate data are collected and the methods of productivity measurement and of the study of productivity problems have developed, we shall be able to enlarge our knowledge on all questions of productivity This would give impetus, precision and force to policies aimed at increasing productivity in all branches of our national economy, on which the future standard of living of the British people depends.

In order to help further research, both the estimates and the statistical basis of these estimates are published in the greatest possible detail. I should like, however, to warn the reader that not all the estimates published in this paper can claim equal reliability and that in any case the global estimates (e g. those relating to manufacturing industry as a whole) are less liable to substantial revision than those relating to individual industries The degree of reliability of the estimates for individual trades is determined by factors such as the complexity of the industry and the availability of detailed statistics. Another circumstance has also played a part—namely, the extent to which the author has been able to take expert advice in interpreting the data. This has varied from industry to industry The qualifications attached to the several estimates are set out in some detail in the Appendices At the same time I should also like to call the attention of the reader to the qualifications

is treated in Chapter I.

I owe a large debt of gratitude to various persons, institutions and firms for assistance, guidance and advice given to me in connection with this investigation, and I want to thank them all most heartily.

I am most indebted to the Executive Committee of the National Institute of Economic and Social Research and to Mrs. F. S. Stone, the Secretary, for encouraging me to carry on with this investigation and enabling me to work on this subject. The Advisory Committee on my larger investigations into 'The Distribution of the Product of Industry', consisting of Mr. N. Kaldor (Chairman), Mrs. Joan Robinson, Mr. W. B. Reddaway, and Mr. Richard Stone were of very great help to me indeed in this work also. They were most generous both with their time and with their practical advice which I gratefully acknowledge, though I take, of course, full responsibility for the shortcomings of this work.

I also received very generous help from persons and organizations abroad working on productivity problems, especially from Mr. W. Duane Evans, Chief, Office of Labor Economics of the U.S. Bureau of Labor Statistics, from the Swedish Institute of Industrial Research, from the Netherlands Central Bureau of Statistics, and others.

In particular, I want to acknowledge the large amount of assistance which I received from many firms and persons expert in their own industry. Whenever there was an opportunity, I have tried to get the best available advice on the many technical matters relating to particular industries. This was, however, not possible in all cases. I am fully aware that the complexities of individual industries, known intimately only to those inside the industry, are sources of innumerable statistical pitfalls. I do not pretend to have avoided all these pitfalls successfully, and at any point should a scrutiny of the estimates by experts of particular industries prove me wrong, I should greatly appreciate their informed comments and criticism.

Mrs. R. Knight did an excellent job in checking up my calculations and helping me with the final draft. I am greatly indebted to Miss H. M. Rogers, Librarian at the Institute, for her tireless help in preparing this paper for the press and for her most careful reading and correcting of the proofs.

I have drawn freely on three previous articles of mine published in the April 1943 and June-September 1945 issues of *The Economic Journal* and the September 1946 *Bulletin* of the London and Cambridge Economic Service. I want to thank the editors of these two periodicals for their kind permission to make use of these articles in my present book.

I wish to make clear that this paper was completed in 1946, apart from corrections and essential revisions, that is, before I accepted an appointment with the Board of Trade.

L. Rostas

National Institute of Economic and Social Research

November 1948

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PART I

CHAPTER I

THE SIGNIFICANCE OF INTERNATIONAL COMPARISONS OF PRODUCTIVITY

1. COMPARATIVE PRODUCTIVITY OF LABOUR AS AN INDICATOR OF REAL INCOME PER HEAD

The main subject of this book is the comparison of productivity of labour as measured by physical output per head or per man-hour in British and American manufacturing industry.

The importance of making comparisons of output per head (or per man-hour) is that they throw light on relative real incomes, and thus on relative standards of living in the different countries. Output per head shows how far at any given moment the different countries succeed in making use of their real resources: of their natural resources, their existing capital equipment and their labour resources, and how effectively labour—this scarcest of all real resources in highly-industrialized countries—is used in their national economies. Output per head will therefore reflect how far at any given time the countries concerned have succeeded in exploiting the natural advantages they may have. But output per head will also reflect the use of capital equipment existing in the countries concerned at that moment.

Higher output per head in one country compared with another means that the available supply of goods and services in relation to its given real resources is higher, and consequently that there are more goods and services available per head of the population.* But comparisons of output per head in final production are not adequate by themselves. Real income per head is dependent on the amount of goods and services available for final consumption. That part of the labour resources which is used in the round-about ways of production, in maintaining the existing capital equipment, does not contribute directly to the flow of final consumption goods and services. If the proportion of such labour in relation to total labour is higher in one country than the other, this will counterbalance advantages of higher output per head in final industries.

2. PRODUCTIVITY OF LABOUR MEASURED IN TERMS OF PHYSICAL OUTPUT PER HEAD

Productivity of labour is measured in this study by physical output per head, which in turn is arrived at by relating the labour force employed in any given industry, e.g. the cement industry, to the total physical output of this industry in the several different countries. Or in other words we estimate the amount of labour needed per unit of physical output (i.e. per ton of cement) in the different countries. We compare output per head in the several branches

* This point will be further discussed in Chapter VI, where the effect of such other factors as distribution of working population, proportion of people working, unemployment, etc. is also analysed.

of manufacturing industry in order to build up a picture of how output per head compares in manufacturing industry as a whole. We then also proceed —in a rougher way—to compare physical output per head in several branches of the national economy in order to build up a picture of how output per head compares in the national economy as a whole of the different countries

This method gives an essentially crude comparison of output per head In manufacturing industry we necessarily confine our comparisons to industries which have a rather simple product structure, that is, which produce only one or a few products, and to industries which produce approximately homogeneous products. Experience shows that even two firms in the same industry of the same country seldom produce identical products, and this will be even more true of whole industries in different countries, since they will be differently organized and market requirements, climate, taste, etc , will all be different. In our comparisons we compare the direct labour requirements needed to produce *the unit quantity* of output, whether a ton of cement, or a pound of yarn, and therefore we neglect the *quality factor*. In some cases it is possible to account for some of the measurable aspects of the quality factor, such as the differences in count of yarn or horse-power of cars, but it is never possible to account for all the quality differences due to variety, size, shape, durability, and style. While it is important to bear in mind the importance of the quality factor in productivity comparisons, it would be mistaken to regard low physical output necessarily as a mark of high quality.

What makes physical output per head a good measurement of relative productivity is that it reflects the joint effect of a great number of influences on production. Relative physical output per head is influenced, for example, by differences in the skill and effort of the workers, but it is equally influenced by differences in managerial efficiency, differing technical equipment, rate of operations, and various other factors *

3. LIMITATIONS OF THE OUTPUT PER HEAD CONCEPT

When relating employment to output and estimating the labour requirements per unit of product, this is confined to an estimate of the direct labour needed,† that is, we estimate, for example, the number of workers (or man-hours worked) in the cement industry needed to produce one ton of cement. But other real resources as well as the amount of direct labour employed are used up in making one ton of cement. For this reason, when making productivity comparisons of individual industries in different countries, in addition to comparing direct labour requirements per unit of output it is also necessary to take into account the following supplementary indices.

(i) Comparisons of the use of raw materials and fuel per unit of output, either measured directly or—if possible—in man-hours.

(ii) Comparisons of man-hour requirements needed to provide that part of

* This question is further analysed in Chapter V.

† i e. we consider the labour used in the cement industry, but not the labour used in the cement-making machinery industry In the cement industry, however, we include both process workers and overhead labour The term direct labour is used throughout in this sense in this study

the capital equipment which is used up in the course of current production (i e. depreciation measured in terms of man-hours)

(i) *The use of raw material and fuel per unit of output*

So far little importance has been attached in discussions to the use of raw materials per unit of output. It has been assumed that manufacturers have every incentive to economize in raw materials They have neither the same motives nor the same freedom in economizing in labour as this depends, among other factors, on their use of capital as well as on the fact that 'labour' means, after all, the use of human beings as a factor of production. But relative economies in the use of raw materials per unit are very well worth investigation. By and large, the same factors, e g. technical progress, which lead to higher labour productivity, will also lead to economies in the use of raw materials per unit; this is illustrated by the example of the development of fuel efficiency. But the inter-relationship of economies in the use of labour and in the use of raw materials may not be quite so simple. Some mass production methods, for example, may involve wastage of raw material such as occurs with a higher proportion of rejects as the cost of labour saving, this can be seen in some of the electrical engineering industries. Or, to mention another type of case, some economy in the use of raw materials may be bought at the expense of higher labour expenditure. It is asserted, for example, that the British wool textile industry possesses unrivalled experience in wool buying, and that by purchasing a mixed lot of wool, with little additional labour the industry can provide tops of the same quality for the worsted section as other countries produce out of more expensive high-quality wool. Thus a slightly lower labour productivity may be counterbalanced by economies in the use of raw materials

Comparisons of use of fuel and power per unit of output have perhaps even greater importance than those of the relative economies in the use of other raw materials, since the use of fuel measures to some extent the substitution of human energy by other sources of energy This subject has not yet been explored sufficiently and it requires further investigation

(ii) *The use of labour needed to maintain capital*

The other supplementary index, which measures the relative labour requirements needed to maintain capital, will depend on two factors the amount of capital used per worker (capital intensity) and the rate of capital replacement.

It is important not to confuse this factor, labour requirements needed to maintain capital per unit of output, with capital employed per worker. In measuring differences in productivity we are interested in the first factor. When we come to analyse the causes of differences in productivity we shall be interested in the second factor, in the use of the tools and machines available for each pair of hands There is, of course, a close connection between the two measurements This can be illustrated in the following way: let us measure capital intensity by horse-power per worker* and labour requirements

* For inadequacy of this measurement see Chapter II

needed to maintain capital by horsepower per unit of output.* We find that the inter-relationship of these two factors is determined in turn by the inter-relationship between horse-power per worker and output per worker Broadly speaking, three cases can be distinguished

If some countries achieve higher level of output per worker only at the cost of employing a disproportionately greater amount of horse-power, then—but then only—there is a strong presumption that these countries use more indirect labour per unit of output. On the other hand, if output per worker shows no inter-relations with horse-power per worker (e g in one country output per worker is higher although horse-power per worker is lower), then the country which needs much direct labour to produce one unit of output will also need much indirect labour, and vice versa. Lastly, if output per worker and horse-power per worker show exactly proportionate differences (e g. double the output per worker is produced by the country with double horse-power per worker), then the amount of horse-power used per unit of output is identical in all countries concerned and there is no presumption—at least on account of capital intensity—that differences in the amount of direct labour used will be counterbalanced by differences in indirect labour used.

Two factors have been ignored in this argument. Firstly, there is the rate of replacement of capital. The higher this rate is in one country compared with the others, the greater are the labour requirements needed to maintain capital. The other factor is the comparative output per worker in the machine-making and constructional industries The higher the relative output per worker in these industries, the lower the relative labour requirements needed to maintain capital per unit of output †

Notwithstanding the need to take into consideration supplementary indices in measuring productivity of labour,‡ there are important reasons why output per worker still remains the fundamental index In any country, given the existing capital equipment and existing natural resources, the most important

* Horse-power per unit of output is, of course, a very imperfect measurement for this purpose In the best case it is a pointer to the size of depreciation on account of capital intensity, but it ignores the other factor the rate of replacement

† In inter-firm (as against inter-country) comparisons this third factor does not operate; therefore the importance of taking into account labour needed in maintaining capital is greater in the inter-firm comparisons

‡ While there are thus good reasons to compute both measurements (i e both the amount of direct labour and of indirect labour used to maintain capital per unit of output), there are equally good reasons for showing the results separately Direct *and* indirect labour used per unit of output will indicate how much of the total manpower of the country is used up to produce this unit, a very important consideration from the point of view of the real wealth of the country.

But only by comparing output per unit of direct labour (irrespective of indirect labour) can we get a picture of the way in which labour is utilized, with given equipment, by individual industries By adding up direct and indirect labour we really bring in the utilization of labour in the machine-making industry as well, e g if we wish to know whether, with their given equipment, the British or the U S cotton industry is more efficient in terms of output per man-hour, we have to compare output per direct labour unit only There is, of course, a *prima facie* case for the higher output per unit of direct labour being associated with more or better capital equipment per worker (which should not be confused with higher indirect labour per unit of output) This, however, as has been explained, takes us beyond the stage of a factual comparison of productivity of labour into the causal explanation of differences in relative productivity

way of increasing real wealth is by better utilization of the labour force Increased output per head will supply additional capital equipment without increasing the proportion of the labour force in this section of the economy Similarly the supply of cheaper raw materials (in real terms) can also be secured by an increased output per worker in the raw material industries, or in the export industries in the case of imported raw materials * Or, to look at the problem in another way, in the national economy it is only the labour force which is an unalterable quantity, while capital equipment and raw materials can be secured and augmented by the productive use of the labour force without sacrifices in real income per head

4. PRICES AND COSTS AS MEASUREMENTS OF RELATIVE PRODUCTIVITY

The question can be asked why not measure relative productivity in international comparisons by comparative prices and costs instead of by output per head or per man-hour? It can be argued that costs would already reflect relative output per head, as one of the determining factors of wages costs, seeing that wages costs account directly on the average for nearly one-fifth of the factory value of manufactured goods and indirectly (adding up the wage content of material, etc , used) for perhaps half of the value In addition, costs would also reflect the economical use of other real resources, raw materials, fuel, as well as the costs of depreciation

International prices and costs will, however, be affected by the prices and costs of these resources, as well as by their economical use, and especially by wage rates. They are thereby a better indicator of competitive ability than of productivity. It is important not to confuse the two concepts the latter is determined by our ability to economize real resources, the former is determined by our ability to sell on the world markets at competitive prices †

* In the latter case the terms of trade also enter into the picture, which may be unaffected by the productivity factor

† An example of this confusion is the argument that although British PMH is much below American PMH, Britain was competitive in the world markets just before the war, since she succeeded in selling her cotton goods and coal, and thereby proved in the most practical fashion her productivity It would not be difficult to prove that Britain kept her share in the markets by relying, not on her productivity, but on cheap labour and by not providing—imprudently—for a renewal of her capital equipment in these industries

While competitive ability may rest either on high output per head, or on low wages (or on both, as the Japanese example showed), it is an entirely different question which is the more desirable Wage rates will depend after all on the supply of and demand for labour, and an ample supply of cheap labour in countries like India and China where capital is in short supply and costs of capital are high, is not an inducement to economize labour and achieve a high output per head But whatever the reason behind low output per head, whether it is the minimizing of private costs or other factors, it will mean a low real income in the community

In any case low wages rates alone cannot be a lasting basis of competitive ability, and few entrepreneurs or nations would rely on it There are several historical examples The U S cotton industry moved south to have the advantages of a cheap and largely non-unionized labour supply But simultaneously firms tried to increase their productivity and thereby incidentally they increased the standard of living of their workers Japan has not relied only on her cheap labour, but also on vast increases in productivity of her textile industries It is also interesting to note that most of the undeveloped countries—such as India or South-East Europe—when they set up modern industries, tend to be technically up to date, irrespective of their inexhaustible supplies of labour

International productivity comparisons are important for the analysis of competitive ability They reveal how far differences in relative costs are caused by relative economies in the use of resources as compared with differences in the relative prices of these resources. But productivity comparisons alone are not enough to throw light on relative competitive ability Neither is a comparison of international prices and costs enough in itself to establish differences in relative productivity When comparing international costs it is important to remember that low costs may be due just as much to low wages rates as to high output per head (i.e. low labour requirements), or they might be due to failure to provide for maintaining capital. Low prices might be due to dumping and high prices to the existence of international cartels All these considerations make comparative prices and costs an imperfect indicator of relative real incomes in the different countries If we add the difficulties of procuring really comparable international prices and costs, we are justified in relying on relative output per head or per man-hour as an index of comparative productivity, and as a pointer to real incomes.

CHAPTER II

PROBLEMS AND METHODS OF PRODUCTIVITY COMPARISONS*

1. THE THREE ALTERNATIVE METHODS OF COMPARISON

Broadly speaking, there are three methods by which output per man/man-hour can be compared in the same industry of different countries. The first, or global, method is based on the comparison of the total volume of output and total employment in the two industries of the different countries The second, or sample, method is based on the comparison of the performance of a small number of selected mills or factories producing identical products under broadly identical conditions The third, or the net output value, method is based on comparison of the value of net output per head in the two countries, converted into the same monetary unit at the purchasing parity rate in terms of the products compared.† The global method has been applied in the

* This chapter deals with some of the fundamental difficulties of international comparisons of productivity in general as well as with particular difficulties encountered, and the methods applied, in this study

† The same three methods can be applied in inter-temporal comparisons of productivity within particular countries For this purpose the application of the third method, based on changes in the value of net output per head, is the least satisfactory, as it requires adjustments for price changes both for materials and for products So far, for purposes of inter-temporal comparisons, we have had to rely almost entirely on the global method, i e by relating changes in output in individual industries to changes in employment in these industries The results of such comparisons are summarized in Chapter IV.

For a large number of industries the U S National Research Project and the Bureau of Labor Statistics have analysed changes of productivity over time as the effect of mechanization These were once-for-all studies of a retrospective type, based partly on plant records, partly on engineering studies

In the future we shall probably be able to measure changes in productivity in time by more accurate direct productivity inquiries of selected sample firms in individual industries An enquiry of this type was initiated (in 1946) in the U S Bureau of Labor Statistics for about two dozen industries by Mr W D Evans and Mr James M Silberman So far reports have been

estimates given in Chapter III of this study The sample method has been used, for example, in the Platt Report. The net output value method has been used in this study in cases such as agriculture as well as being employed as a supplementary method for the individual manufacturing industries. The three methods are by no means mutually exclusive, on the contrary, they are complementary to each other, but each of them also provides specific information not given by the other methods. It should be noted that all three methods compare output produced by a unit of direct labour, and do not make allowances for the labour used in the making of machinery which is employed in the process of production. .

(1) *The sample method*

In the case of the sample method the usual procedure is as follows: a small number of typical mills or factories are selected in each country, taking into account as far as possible such factors as the nature of the product, the com-

issued on trends in man-hours expended per unit for selected machine tools, industrial equipment, construction machinery, radio receivers, foot-wear, fertilizers, shirts The period to which these reports refer is usually 1939 to 1945

The primary purpose of this investigation is to measure current changes in productivity by securing *reports on unit labour requirements directly from the manufacturers.* These reports are based on manufacturers' production and engineering records and the labour requirements data are shown for *products* and product groups within industries Data on unit labour requirements are obtained for a sample of production in each industry or industry segment, i e each industry is represented by a number of closely defined products, made to competitive specification (if possible shown in the catalogue of the firm) Products are chosen in such a way that they represent, as far as possible, the distribution of the industry's production according to product type, size, complexity of design, method of fabrication, operating characteristics, and volume of production Only relatively standardized items produced in large volume are, however, selected, since comparable man-hour requirement data are usually not available for custom-manufactured products

Apart from exceptions when all establishments in an industry are covered, usually a sample of establishments is selected for reporting They are selected on the basis of a number of factors, of which size, location, integration, etc , are of primary importance

Reporting of man-hour data is confined generally to companies with records which readily yield accurate information covering the specified product models

The Bureau of Labor Statistics aims at, primarily, compiling *time trends* in productivity changes on a yearly basis, going back to the pre-war year of 1939 and from the present on continuously In industries where the product of the firm is rather specialized they are satisfied with time trends (this was the case e g in machine tools), but in industries where the product of different firms is fairly comparable *an inter-firm comparison is also attempted* and absolute figures on man-hour requirements as well as indices on time changes are compiled. But even in industries where absolute figures would be misleading the changes in time are shown for so many cross classifications (size of firm, type of process, regions, firms which put in considerable new capital, firms which put in none, etc etc) that some conclusions on the relative merits of different types of firms and different types of business policies can be deduced In addition to the compilation of the quantitative information an account is given of the principal factors which might have been responsible for these changes, such as innovations in machinery, equipment and work methods, integration of manufacturing facilities, specialization of output, and changes in design of product A quantitative appreciation of these factors, though highly desirable, would be extremely difficult and it has not yet been attempted

This type of investigation once it is undertaken in several countries has obviously great potentialities for more accurate international productivity comparisons

A successful application of the sample method has been used for purposes of inter-firm comparisons in cotton-spinning by the Shirley Institute. See L H C Tippett, 'The study of industrial efficiency, with special reference to the cotton industry', *Journal of the Royal Statistical Society*, Part II, 1947, pp 108-22

position of the labour force in terms of the proportion of males and females, etc , location, size of producing unit, technical integration, type and condition of machinery, etc.; the complete operation of the selected mills or factories is then observed and measured and the results compared The question which is investigated in such cases is how many man-hours have been used up in the different processes of production to produce a given quantity—a lb. or yard or ton of goods—or alternatively what quantity of output has been produced in the several cases by a given identical labour force. There are a great many advantages attached to this method. The main advantage is that it gives more information than the global method in the sense that it compares separately each phase of the productive process and thus indicates at what stage and in which part of the process are there substantial differences to be observed. The Platt Report, for example, indicated that although output per man-hour is much higher at every single stage of cotton textile production in the U S. than it is in Britain, it is particularly high in the stage of winding and beaming. Again American studies relating to changes in productivity of labour in making cement pointed out that the greatest savings in man-hour requirements have been (and could be) achieved in the stage of drying and packing It is also an advantage of this sample method that it eliminates the effect of a number of structural factors such as location and size and thus concentrates attention on what is, in many ways, the main aspect of the problem, the production methods closely associated with the type of technical equipment used But this same process of trying to eliminate the effects of some of the structural factors is obviously one of the shortcomings of the method. When typical British practice in making cotton cloth is compared with typical American practice, it is obviously useful to choose mills the performance of which is suitable for such a comparison, and will thus enable us to evaluate the differences between the two practices. But by choosing two mills which have either an identical number of people employed or which produce identical volumes of output, an important factor—the size distribution of the plant in the industry as a whole—has been eliminated from our considerations. It is in this way that the global method—based on actual conditions of production—is a valuable instrument of comparison

It will usually be extremely difficult to find mills and factories which are not only typical in so far as the production process is concerned, but are also typical in so far as size, location, labour force, etc., is concerned. There is always, of course, in addition the usual difficulty of defining what is typical or representative, and this is all too often identified with the average These difficulties usually defeat the possibility of making a genuine sample comparison, which is then reduced to the comparison of one genuine and real position based on samples with another which has been artificially built up from estimates of imputed performance of the installation; or it may even be reduced to a comparison of two artificially built up positions To a smaller or greater degree all sample investigations become engineering studies rather than purely economic comparisons The Platt Report compares the actual practice in selected sample mills with British practice, the latter was not based, however, on the records of actual mills, but the performance of typical

plants was evaluated, on the basis of actual experience, and these plants were assumed to produce the same weight of the same yarn counts and cloth types as the American mills The American studies which analyse changes in labour productivity in time usually compare not actual changes, but changes which would be possible on the assumption that in both periods the best possible machinery then available would have been used by good management It by no means follows from this limitation of the sample method that its results are not valuable But this type of comparison is perhaps more suitable to indicate how such factors as the state of mechanical equipment and machinery development affects output per man-hour than to show what the actual situation is In any case, it is useful to bring into consideration eventually those other factors which are eliminated by the selection of the units of production compared. It may be added that the application of the sample method requires complete technical knowledge of the processes of industry as well as a good judgment as to what is typical practice in the industry and which units should be chosen for comparison *

(ii) *The global method*

The global method is applied, broadly speaking, in the following manner: quantitative data on the production of comparable commodities (or groups of commodities) are computed and then the number of operatives and of total employees producing the respective quantities are ascertained As far as possible, allowance is made for differences in quality, but a great many non-measurable differences in quality will be neglected On the basis of these figures physical output per head for both countries can be worked out and then compared If the average actual hours of work per week are also known in both countries a comparative index of physical output per man-hour also can be calculated. This question is further discussed in section 2 of this chapter This somewhat crude index of comparison of output per man/man-hour is a more reliable measure of relative productivity of labour than the one based on a sample investigation, in the sense that it shows what the actual situation is and not what it would be under certain circumstances This index expresses the state of affairs prevailing, under the influence of all the factors at work, whether economic, social or physical, and thus makes possible the analysis of

* It appears that the Platt Report is a successful application of the sample method, as it makes allowances for many of the variable factors It is for this reason that in this case estimates based on the global method corroborate the findings of the sample method But even in the case of the method used in the Platt Report allowances had to be made, e g for the fact that the U S sample chosen is more representative of the *up-to-date* section of the industry than of the whole U S industry, or that non-integrated mills were not included in the sample except in fine spinning, or that in the case of British practice it has been assumed that British plants produce the standard counts taken, and do not divide up production among a wider range of counts, etc

Most of the U S studies to which reference has been made do not show more than the potential effects of mechanical changes on productivity of labour a comparison with actual changes—such as were worked out by Fabricant or in other studies of the Bureau of Labor quoted in the Bibliographical and Statistical Note, pp 249–251—will reveal differences, indicating that factors other than mechanical changes affect productivity Long-term changes in the productivity of the U S cotton industry are a good example See L Rostas, 'Productivity of Labour in the Cotton Industry', *The Economic Journal*, June-September 1945, p 200

these factors For the same reason it is important to realize the limitations of this method. It results in a global figure, and when it comes to interpretation it is useful to bear in mind that physical environment as well as institutional factors are affecting it.

The application of the global method is a much simpler procedure than the application of the sample method. The correct application of the global method involves, nevertheless, a considerable number of technical difficulties.*

(iii) *The net output value method*

This method is based on comparison of the value of net output per head converted into the same monetary unit at the purchasing parity rate in terms of the products investigated. For this purpose it is necessary firstly to list the main products of the industries to be compared, and secondly to ascertain the prices of these products in both countries. It would be even more appropriate to ascertain the purchasing parity rate for both the finished products and for the materials which were used in their manufacture, and thus to calculate an exchange rate which corresponds more to the concept of net output.† Prices, of course, must relate to identical products as well as to identical conditions of sale, for example, 'ex works' or 'delivered at site', and so on. The ratio of such prices gives the exchange rate in terms of these products. The ascertainment of comparable prices is not easy, if possible at all. Two supplementary methods can be applied, neither of them being very satisfactory (1) instead of the purchasing parity rate the official exchange rate merely can be applied, which expresses price differences in terms of all commodities and not only of those under investigation; (2) the exchange rate in terms of average factory values (as ascertained from the *Census*) can be calculated. This would be identical with the purchasing parity rate only if the average product of the countries compared were identical (which is very seldom indeed), but the differences between this rate and the general exchange rate usually gives some indication of the direction in which the purchasing parity rate would deviate from the general exchange rate

The great advantage of this third method is that it takes into account quality differences in the product (in so far as these are reflected in price), as well as in the labour force used; it also allows for the different amounts of fuel and materials used, which the global method does not do, and thereby serves as a useful supplementary means of comparison. Within a clearly-defined industry the net output value method is a good rough measurement provided the producers are making broadly the same sorts of articles, and that it is reasonable to presume that buyers are sufficiently well informed to ensure that prices are kept fairly well in line

* These are discussed in section 2, below

† Once the purchasing parity rate in terms of the product investigated is available, it is conceptually quite correct to apply this rate to the value of gross output per head, provided the same range of processes is covered in both countries This method of converting the value of gross output per head in both countries at the purchasing parity rate approximates more to the physical output per head comparison than does the use of the value of net output per head method

2. PITFALLS OF THE GLOBAL METHOD

As it is the global method which very largely has been applied for purposes of this study, a more detailed discussion of the difficulties of its application is necessary. These difficulties are mainly due to the fact that individual industries, as classified by the *Censuses*, each produce a group of products and by-products which are not identical in the different countries, either as regards type or quality or as regards the relative importance of individual types within the group. As a result, comparisons of physical output per head can be made only for a certain number of industries for which quantitative data are available and where the output can be reduced to a sufficient degree of homogeneity. A second complication arises from the difficulty of covering precisely the same range of productive processes in the two countries compared.

The difficulties which arise are usually of two types and are broadly similar to those which are encountered in almost all discussions of industrial problems; one relates to the definition of the industry, the other to the definition of the product Some of the difficulties on both accounts are due to the fact that the industrial classification, as presented in the production *Censuses*, the main source of material for the global method, is not detailed enough for this purpose or is not identical in the two countries to be compared. In many cases there are also inherent difficulties, which are independent of the statistical material available.

A few instances of the difficulties encountered will indicate the character of the problem.

(i) *Difficulties arising out of the definition of an industry*

The first group of difficulties is connected with the definition of an industry.

(1) The output of the industries compared will consist not only of the output of the main product(s) in which we are interested but of some other by-products or ancillary products, and therefore part of their labour force will be used for producing these latter products.

(2) A corollary of the first difficulty is that part of the main product in which we are interested is produced as the by-product or ancillary product of some other industry Thus the motor-car industry may produce such ancillary products as aircraft engines and parts, wireless apparatus, electrical machinery, tractors, etc. At the same time some part of the motor-cars may be produced in other industries than the motor-car industry. In fact, the *Censuses* give for every single industry distinguished a 'carry-in' table covering production of main products by other industries and a 'carry-out' table covering production of 'other output', i e. by-products or ancillary products which are main products of other industries. In both cases mentioned, the proportions of the labour force and of the product involved may differ in different countries.

(3) Industries as defined by the *Censuses* may cover a different part of the productive process Cement-making may include or exclude quarrying of lime and chalk. Again in all the textile industries textile finishing may be treated as

part of the cotton or woollen industry or as a separate industry. This will depend on the actual technical integration in the industries concerned, and secondly on the *Census* treatment of such subordinated industries The usual procedure is to classify each plant into one industry on the basis of its main activity. But if the *Census* regards the subordinate processes as separate industries and data relating to the performance of the plant covering the whole process can be divided up, this is usually done

(4) Industries compared may perform a different number of processes, even if they cover roughly the same scope. The steel industry is the most obvious example. Two steel industries compared may differ because the one is producing all its raw steel, while the other is importing part of the bars, etc , or they may differ because one is taking re-rolling a stage further than the other.

(5) Industries compared may differ in scope when part of the production process consists of making parts and accessories, and the other part consists of assembly This problem is especially important in practically all engineering industries. The motor-car industry is a good example. To make a comparison between the motor-car industries of two countries one can attempt one of two things to compare the assembly work solely which is a difficult proceeding considering that in practice assembly and the making of parts and accessories are not at all easily distinguishable, and this would be reflected in the statistical material available; or one tries to compare the whole process of the making of the motor-car, including the making of parts and accessories The choice of processes and activities to be included is sometimes arbitrary—making radiators is regarded as part of the motor-car industry, while making tyres is not—but in so far as an identical range of activity is covered in the countries investigated, the arbitrary factor will not have much effect.

(5a) A special case, similar to the one given under (5) above, arises when it is not the two processes of making parts and of assembly which are separated, but when the scope of the industry is reduced by a great deal of pre-fabrication of its 'raw material'. Again comparison mainly of engineering industries would show that in the one case the industry starts at the steel stage, while in the other it starts at the stage of machining pre-fabricated parts.

(6) Ancillary manufacturing activities may be performed either within the industry investigated or outside the industry, for example, making packing material or printing, etc. In so far as these activities are not treated as separate industries by the *Censuses* differences will arise

(7) Repair and maintenance of installations may be included in the industry (i e into the labour force) or they may be treated separately.

(8) Non-manufacturing activities may be performed by the industry or may be performed outside the industry. The two main examples are transport and generating electricity.

(ii) *Difficulties arising out of the definition of the product*

A host of other difficulties arise from the definition of the product.

(1) To start with, it is possible only to compare industries the product of which is broadly homogeneous That is, they produce mainly one product

such as cement or different sub-groups of the same product such as men's shoes, women's shoes, and so forth. It is not possible to compare industries with a heterogeneous product structure, such as chemicals or plate and jewellery In many cases the difficulties are purely statistical, where we have an insufficient breakdown of the industrial classification Comparison—on a physical basis—is sometimes impossible even in regard to homogeneous products owing to the lack of information about the quantity produced; or, where the information is available, it is given in non-comparable units Thus, engineering products in the British *Census* are given throughout in tons, while in the U S *Census* they are given in number of actual products manufactured.

(2) Even in cases where there is one product in the industry, if this product consists of a number of sub-products, such as different types of shoes or different types of motor-cars, the difficulty arises in converting these sub-products into one homogeneous product. In this respect international comparisons present perhaps a smaller difficulty than, say, inter-regional comparisons, as there is more likelihood that the product structure of two countries will be broadly similar The proportion of men's and women's shoes in the total number of shoes produced in the U K. and in the U S. will perhaps not differ very much, whereas the product structure of, say, England and Wales would differ.

(3) A similar problem arises when instead of many sub-products there is one main product and a number of by-products, all specific to the industry under investigation Thus in the case of the coke industry, coke is obviously the main product, but gas, coal, tar, etc , which are by-products of the trade have to be considered, too

(4) Another type of difficulty is when the two industries compared produce the same product, but also produce for sale intermediate products, and the proportion of intermediate products for sale in relation to the total product varies. For example, the British cotton industry—so defined as to include spinning and weaving—has two main products yarn, which is an intermediate product for its other main product, cloth, whereas the U.S. cotton textile industry has broadly only one main product, cloth, and the bulk of the yarn produced is used in the same plant or is transferred within the industry.

(5) A similar type of problem arises in engineering where parts and accessories are mostly assembled into the finished product, such as motor-cars or wireless sets, but the same intermediate products are also sold to the final consumer for replacement

(6) A number of complications arise on account of qualitative differences. In using the global method we compare the average British motor-car of 12 h p. with the average American motor-car of 30 h p., or the average British cotton yarn of 27's counts with the average American yarn of 22's counts in 1937. In so far as these quality differences have a bearing on the amount of labour needed per unit—and they usually have—and this difference is measurable in any way, allowance should be made for it. It is obvious, however, that it is not possible to make allowances for non-measurable differences in quality,

such as differences due to durability, style, fashion, etc. Different makes of shoes are an obvious example; different types of woollen cloth another.

But even beyond such quality differences which can be easily observed and appreciated by the layman there are further differences in 'technical qualities' of apparently similar products. These 'technical differences' may take the form of differences in chemical, physical, rheological or similar properties of the product or they may consist of differences in the tolerances of manufacturing specifications. These differences may often be invisible to the consumer, and yet each manufacturer may attach particular value to the specific technical qualities of his product, and a higher technical quality may involve the use of more labour per unit.

(7) An entirely different type of difficulty arises in regard to 'differentiation' of the product. One country may specialize in a small number of varieties of the product, in other words its production is standardized, while the other country for some reason or other may go in for great variety. This, however, is not a problem of methods of comparison, since it relates to the structural factors affecting output per head; it is comparable to the size of plant or the character of the labour force, and will be discussed together with these factors in Chapter V. No primary allowance can be made for it in the estimates of differences without eliminating the effect of one of the factors influencing the difference itself.

3. THE MEASUREMENT OF INDIRECT LABOUR USED TO MAINTAIN CAPITAL

The global method, as explained, does not take into account either the indirect labour needed to maintain capital or the indirect labour needed to produce fuel. The importance of these supplementary measurements has been discussed in Chapter I * The next two sections will discuss the ways in which such measurements can be attempted.

In principle, four factors will determine the quantity of indirect labour used to maintain capital:† the amount of capital (machinery, etc) used per worker, the amount of labour needed to keep the machinery at an optimum working capacity (i e labour needed for maintenance and repair), the rate of replacement of capital and lastly the output per worker/man-hour of the machine-making and constructional industry There are several difficulties in measuring the quantity of indirect labour used per unit of output. It is obviously extremely difficult—if not impossible—to devise a single physical measurement of all the single tools, machines, equipment, buildings, etc., used in the process of production, that is, to devise a physical index of total capital. Moreover, exact or even approximate measurements showing the man-hours necessary for the making of every single piece of tool, machine or building are not available.

* See Chapter I, p 2

† A more appropriate term for such labour would be 'investment labour' or 'equipment labour'. The term 'indirect labour' is used throughout this section in this sense

One way of measuring the relative use of indirect labour is to estimate the annual amount of *money* needed for true depreciation; this will take into account both the amount of capital used as well as the rate of replacement based on the estimated life of the assets. This money sum can then in turn be converted into man-hour terms on the basis of the value of gross output per head in the engineering and constructional industries concerned. This is, of course, a very crude method. Since gross output per head will show wide variations in different engineering and constructional industries, and since our depreciation figures are never detailed enough, the results will always be very approximate. A more serious difficulty, however, is how to ascertain the amount of yearly depreciation and how to agree on the right principle for representing true depreciation. In the latter respect the right principle would appear to be to take the long-term view and calculate depreciation on the basis of replacement costs, that is, to calculate the man-hour costs per unit of replacing existing equipment, assuming such an average life as is reasonable on the basis of present technical development and of expected wear and tear of the machinery A variation of this method has been applied in this paper by estimating the number of persons engaged in making machinery and in constructional work, in relation to the total number of persons engaged in United States and United Kingdom industries respectively. This kind of calculation, however, does not make allowances for new investments.

As depreciation data are seldom available, a supplementary method is to look for some partial physical index of capital, instead of a total one, e.g. the amount of specific equipment, or horse-power used, and then to compare the ratio of this partial physical index of capital to output in the two countries, as well as comparing the relative productivity of labour in producing the capital.

In a few cases only—as in some of the textile industries—is it possible to compare the major pieces of capital equipment used per unit of output, and even here differences in type of equipment such as that between automatic and non-automatic looms make such comparisons of rather doubtful value. One usually falls back on the only easily available method of comparing total horse-power used per unit of output, which in spite of its many shortcomings —especially if adjusted for differences in productivity in machine-making— will give a rough indication of the differences in labour used to maintain capital. The main difficulties in using horse-power data in international comparisons of productivity are.*

(1) that 'horse-power' is not a very comprehensive physical characteristic of

* There are a number of other difficulties involved in using H P indices, e.g differences between horse-power installed and used, differences between British and American ascertainment of horse-power, differences between British and U S. *Census* methods in calculating total horse-power available, etc See the following publications of the National Institute of Economic and Social Research (Cambridge University Press) L Rostas, *Productivity, Prices and Distribution in Selected British Industries*, p 15, and Sargant Florence, *Investment, Location, and Size of Plant*, Ch v, also *Final Report of the Fourth Census of Production* (1930). For purposes of this study, total horse-power used has been calculated mostly by the simplified U.S. formula of adding up H P of prime movers and of electric motors using purchased electricity The comparison should be made on the basis of horse-power installed, and not 'in use', but as it is probable that the horse-power 'available' in Britain includes some obsolete equipment not in use at all, for Britain the 'horse-power in use' data have been applied

machinery; it does not necessarily indicate the labour-saving character of the equipment, neither does it indicate how much labour went into making the machinery;

(2) the trend of technical development appears to be to increase the performance of the machine without increasing (or even decreasing) the number of horse-power;

(3) horse-power data alone say nothing about the age and actual performance of the machinery, and thus do not indicate how much useful machinery is at the disposal of the worker per unit of output (comparison of horse-power per worker in cotton spinning in the U K. and U S raises this problem acutely),

(4) horse-power at best gives only an indication of the amount of capital used but says nothing of the rate of replacement.

Unfortunately even this rough index of measurement is not available either for all countries or for all years In the U S. it is usually ascertained once in ten years when the Census of Manufactures is undertaken as part of the decennial Census, and is available for 1929 and 1939. In the U K. it has been ascertained for the purposes of the 1907, 1924 and 1930 Censuses, but not for 1935.

4. LABOUR NEEDED TO PRODUCE FUEL AND POWER

As has been pointed out in Chapter I, in addition to the labour which is needed to maintain capital it is also necessary to consider the additional number of people needed to produce the energy which replaces hand labour If we consider the same industries in two countries, where in country A the process is entirely mechanized, while in country B the labour in some processes is done by hand, it is obvious that country A will need indirect labour not only to maintain and replace the machinery installed, but also to produce the fuel which feeds these machines The number of people therefore who are engaged in producing this extra fuel are an additional indirect labour force counterbalancing to a certain extent the savings in direct labour

The difficulties in measuring this factor in statistical terms are formidable To start with, it is impossible to distinguish between the consumption of energy for this 'replacement' purpose and all the other uses of energy, for heating, lighting, power, raw materials, etc. But if we disregard the last factor, that is the use of fuel as a source of raw material, as well as such small items as, say, insufficient heating and lighting (which are not economies in the real sense), it is perhaps true to say that a low use of fuel per unit of output is an indication of higher productivity.*

But the measurement of the total amount of fuel and power used per unit

* e g the cement industry in country A is fully mechanized, while in country B, say, drying and packing is done by hand In country A some extra fuel will be needed to feed these extra machines, and to this extent fuel used per unit of output would be higher If, however, country A uses much less fuel, say, in the kilns, and its fuel consumption for all purposes per unit of output is smaller than that of country B, this is clearly a point in favour of country A

of output, either in a particular industry or in industry as a whole, is also extremely difficult. It necessitates, namely, the conversion of the different types of sources of energy into one homogeneous unit. Such a conversion, whether it is attempted within one country or between different countries,* will depend on the so-called efficiency coefficient in turning coal into coke, gas and electricity, etc. And it will depend even more on the efficiency coefficient in applying these different sources of energy, coal, coke, gas, electricity, oil, etc., in industry This latter coefficient will differ substantially both from industry to industry and according to the particular form of use, not to speak of inter-country differences Any sensible conversion therefore has to be postponed, until more information is available on these efficiency coefficients

There is one way, which is a very approximate one, of indicating the amount of real resources used in the form of all kinds of energy. This is to express them in terms of the men needed to produce them. This can be conjectured on the basis of data on the estimated output per head in the energy-producing industries The disadvantage of this approach is that it brings in the differences in productivity in the energy-producing industries, and this is largely determined by natural factors.

5. INTER-REGIONAL COMPARISONS OF OUTPUT PER WORKER/MAN-HOUR

No attempt has been made in this paper to make inter-regional comparisons—for example, as between Scotland and England—as contrasted with international comparisons But it is obvious that the same technique can be applied for such purposes Inter-regional comparisons are easier in the sense that—unless the industry to be compared in the two regions produces entirely different products, or prices or wages consistently differ—the third method, comparison of the value of net output per head, can always be applied, and this provides a valuable check on comparisons of physical output per head

Comparisons of physical output per head/man-hour are, however, sometimes more difficult regionally than internationally, as the product structure of two regions will differ more than the product structure of two countries A good example is the boot and shoe industry where the product structure between the U.K. and the U.S. is similar, while between different regions it is entirely dissimilar. Only if each of two or more regions to be compared had a broadly identical industrial structure could such comparisons easily be made. This is obviously not the case, owing to far-reaching regional specialization. On the whole, regional comparison of non-localized industries, such as bricks, bread, brewing, clothing, etc., is more promising than that of strongly-localized industries, such as boots and shoes, steel, cotton, textiles, hosiery, etc

* Inter-country comparisons between the U.K and U S are, of course, more complicated owing to the fact that the range of sources of energy used is different In addition to coal, coke, manufactured gas, and electricity, the U S also use natural gas and home-produced fuel oil

Similarly, difficulties may arise in estimating the labour force performing processes of production, especially when, for example, prefabrication or making of parts is performed in one particular region only, while assembly is done in both. The motor-car industry is the obvious example with parts being mainly made in the Midlands and assembly performed often near and around London.

6. HOW THE GLOBAL METHOD HAS BEEN APPLIED TO THIS STUDY

Section 2 indicated the types of difficulties which were encountered in the application of the global method. In this section we will discuss some of the simple statistical techniques by which these difficulties have been dealt with.

(i) *Basic information used*

The production censuses which supplied most of the basic material for the purposes of this investigation are very satisfactory, in the sense that they give a consistent set of statistics, covering for each industry

The quantity and the value of the products of the industry from which the average factory value per unit of physical output can also be calculated;

The total value of gross output (sales value of all products) of the industry;

The total value of net output of the industry (gross output less costs of materials);

The total number of employees (operatives and salaried persons);

The total number of operatives.

A vast number of industries are treated as sub-groups of other industries in the 1935 British *Census of Production*, and for these industries the total number of operatives is not available. For such industries the number of operatives can be estimated on the assumption that the ratio of employees to operatives is the same in the sub-group as in the relevant main group

For such sub-groups the quantity and value of output of the products is also not given separately, but only for the group as a whole It is, however, not difficult to ascertain which products should be associated with the particular sub-group.

(ii) *Conversion of different sub-products into one homogeneous product*

Where the industry to be compared produced more than one commodity (say coke and gas) or different types of the same commodity (say shoes for men and women), they were converted into one homogeneous product either on the basis of physical weights, as in the case of the different types of pig iron, or—and this is by far the more important method—on the basis of their relative values, as in the case of the different types of motor-cars or

simply as an index number problem, relating to the volume of output.* the individual components of output were revalued (weighted) by average prices (factory values) of both countries and the average of the two aggregate values taken as measurement of the total output

A more accurate weighting could be achieved by using the net output values which take into account the labour costs as well as the gross margins (which reflect costs of machinery and organization) going into the different types of units. Unfortunately, however, net output values are seldom available for single products but only for the industry as a whole †

(iii) *Determination of number of operatives (employees) associated with a particular physical output*

In order to make allowances for the number of persons employed for the by-products and ancillary products not taken into consideration in the comparison, as well as to allow for those persons producing part of the main product but classified into other industries, a primary adjustment has been made in all cases The total number of persons employed as given in the *Censuses* relates to the total value of the gross output of the trade. As the total value of those products which are included in the comparison ('including the carry-in part of the output') is also available, the number of persons employed can be corrected for differences The correction factor is given by the ratio of the value of included products to the total value of gross output. It will be usually somewhat below unity, though in cases where the value of 'carry-in' is higher than the value of 'carry-out', it would be higher than unity. This is the usual method followed, and it is in fact the only method available in practice. The unstated assumption underlying this method is that the value of gross output per head is the same in the case of the main product and of the excluded products, or that it is the same in respect of the main product produced in the industry and outside the industry. As this assumption is perhaps not a very satisfactory one, this method of adjustment can be used only when the proportions of 'carry-in' and 'carry-out' are both small.

If the total value of the product specified both by quantity and value does not account for the major part of the total value of gross output, the method of adjustment described above is unsatisfactory, in the sense that the number of persons associated with the particular output cannot be reliably estimated.

* In using the usual index number method for converting several types of products into one homogeneous product a further difficulty might arise in cases where only part of the output is given in both quantitative and value terms and another part in value terms only. This same problem arises, of course, in calculating a time series of indices of production for one country Two assumptions can be made it can be assumed either that the quantity of the non-specified products compares in the same way as that of the specified products or that the prices of the specified products are in both countries proportional to the prices of the non-specified products (See the controversy between Mr Rhodes, Professor Bowley, and Mr Devons Sources are given in the Bibliographical and Statistical note on p 249) In most cases where this type of problem arose, a third method was applied We estimated the amount of employment needed to produce the output shown in terms of quantity by means of reducing total employment in this industry by the ratio of the value of output shown in terms of quantity to the total value of output of the trade See section (iii) below

Another case when this method is not applicable is when it can be assumed that the total value of gross output contains a large amount of duplication. Duplication in the value of gross output is a clear warning that great care should be taken in the comparison of the processes covered. But while in the case of duplication there is at least an indication that more than one process is covered (in the sense that the value of all the final products will not add up to the total value of gross output), in cases of technical integration there is a similar pitfall, but there will be no indication of it at all These pitfalls can be illustrated by the following example. If we compare cotton weaving in the integrated cotton mills in the U.S with cotton weaving in the unintegrated British mills, the basic figures—quantity and value of piece goods produced, the total value of gross output, number of persons—on the surface appear to be comparable The total value of gross output is largely accounted for by the value of piece goods produced. In reality, however, there is a vast difference, and a large, in fact the major, part of the employees in the U.S. has been engaged in making yarns, without this additional activity being reflected in any of the figures used for comparison. In this particular case the intermediate product was transferred within the same plant or within the different plants of the same firms and did not appear in the final value of gross output If a great proportion of the intermediate product were sold within the industry, the data relating to the final product of the industry would be the same, but owing to statistical duplication there would have been a substantial difference between the value of total gross output and the value of the final product or products

There is no single method by which differences in the processes covered can be detected or which indicates the ways in which adjustments can be made. The way in which an attempt has been made to deal with such industries as motor-cars or wireless sets will illustrate the actual methods which can be employed

(iv) *Inclusion of non-manufacturing operatives*

To an unspecified extent the *Census* employment figures include persons employed not in the manufacturing process proper, but in repair and construction work, transport or generating electricity. This factor affects the margin of error of comparisons only in so far as the proportion of such people to manufacturing employees differs in the two countries—a question on which hardly any factual information is available.

Operatives in the British *Census* are defined as 'covering all wage-earners, including foremen, van and lorry drivers and warehousemen, employed in or about the factory or works, or in outside work of construction or repair'. The definition of the 1937 U S. *Census* reads: 'all time- and piece-workers employed, including power plant and maintenance, shipping, warehousing, and other departments, working foremen and gang and straw bosses, are treated as wage-earners'. These two definitions do not suggest non-comparability, especially if we consider that 'shipping' in the American terminology covers packing and conveyance to transport means, and it also may include transport itself.

The 1939 American *Census* introduced a substantial change which for the time being, however, does not clarify the issue, in fact, if anything, it makes it more confused.

The 1939 *Census of Manufactures* questionnaire, for the first time, called for personnel employed in distribution, construction, etc, separately from the manufacturing employees of the plants, and therefore—as the *Census* states—the data for earlier years are probably not strictly comparable with those for 1939. The new information did not throw light, however, on the question how many of the wage-earners and of the salaried employees, reported at previous Censuses, were engaged in distribution and construction, and how many were engaged in manufacturing?

The total number of persons reported by manufacturing establishments for 1939 are now divided in the detailed industry reports into the following categories:

Salaried officers of corporations
Manufacturing:
    Salaried employees
    Wage-earners (average for the year)
Distribution
Construction
Other

There is no indication, however, of what proportion of the persons employed in distribution, construction, and other manufacturing activities were salaried employees and operatives respectively

In so far as *wage-earners* are concerned the 1939 questionnaire simply called for the number of *wage-earners engaged in manufacturing*, but it did not provide for reporting separately the wage-earners engaged in distribution, construction, and other non-manufacturing work, as it did for total employees It is also worth noting that the definition of wage-earners was a much narrower one for 1939 than for previous years 'wage-earners in manufacturing plants are, generally speaking, those who perform manual work, using tools, operating machines, handling materials and products and caring for its plant and equipment'.

Notwithstanding this new definition of wage-earners, the 1939 *Census* makes no distinction between the wage-earner data collected for 1937 and the wage-earner data collected for previous years, and this can be regarded as an indication that it did not find reasons for non-comparability In the case of salaried personnel, however, the *Census* found that especially in such cases as 'food, apparel, and printing and publishing industries, where distribution constitutes an important part of the activities of the establishments, the 1939 figures for salaried personnel engaged primarily in connection with manufacturing indicate marked decreases as compared with corresponding figures for earlier years, these decreases not being in harmony with changes in numbers of wage-earners. It must be assumed that some of the personnel reported for earlier years as engaged in production activities or in activities connected

with production were reported for 1939 as distribution or other non-manufacturing employees '

The upshot of this innovation is that, in so far as salaried personnel is concerned, it is proved that U S. *Censuses* prior to 1939 included persons engaged in distribution, etc., but in so far as wage-earners are concerned it appears that this factor is either of no relevance or at least cannot be ascertained. The statistics at present available do not allow further clarification of this point, but it is hoped that future *Censuses* both in the U.K. and in the U S will be collected in such a way as to make clear what the position is

A problem similar to the inclusion of transport, construction and other non-manufacturing personnel, is the question of the personnel employed in generating electricity. There is obviously a choice for each firm or plant either of generating its own electricity or of purchasing it outside, or of having combinations of these two alternatives The persons employed in generating electricity within the firm are obviously included among the manufacturing personnel in both of the U.S. and U K. *Censuses* Thus in this case differences may only arise from the fact that the ratio of total electricity used to purchased electricity will be different. This ratio can be measured and thus an estimate can be given on the order of importance of this factor *

(v) *The composition of the labour force: inclusion of salaried persons*

Once the scale of the industries to be compared is satisfactorily defined, the questions that follow are, firstly, whether a comparison of output per employee or per operative is the relevant index, and secondly, whether different types of labour, men and women, juveniles and adults, should be aggregated, or whether a weighted labour index in terms of 'men' employed should be calculated.

A comparison of output per employee and of output of operative are of equal significance. Differences between the two indices would indicate how far the hypotheses that increased productivity per worker is somewhat counterbalanced by increased number of salaried persons employed is borne out by the facts But differences, of course, might also be due to differences in classification

Figures relating to operatives are usually ascertained by the *Censuses* for a certain date in each month of the census year and thus a reliable figure of the average number of persons employed during the year can be given. As it is also safe to assume, at least in U.K. and U.S. comparisons, that the distinction between operatives and salaried personnel is quite clear, the index of comparison based on output per operative is the more reliable measurement

The number of salaried personnel is usually ascertained for one particular week in the census year. The British *Census* has, throughout its course, used the following definition. 'Administrative, technical and clerical staff' cover 'the office and management staff (including working proprietors, managing directors, managers, designers, salesmen, travellers, etc.)', clerks, typists, and other persons engaged primarily in office work were recorded as "Administrative, technical and clerical staff', and not as 'operatives'.

* See Chapter III.

The U S *Census* has made a number of changes in its definition of salaried personnel The *Censuses* up to and including 1937 distinguished between three categories of salaried personnel. salaried officers of corporations, supervisory employees, and clerical and other salaried employees. For years prior to 1937 and in 1939 the questionnaire called for 'salaried officers of the corporation', for 1937 it called for 'salaried officers of the corporation whose duties are concerned wholly or chiefly with manufacturing'. The effect of this change was, however, negligible.

Another—more important—change in 1937 and in 1939 was that persons employed in central administrative offices were not included among the salaried personnel, which affects comparability for previous years. Lastly, the comparability of the data for 1939 is also affected by the segregation of non-manufacturing employees discussed above.

The only practical way of dealing with the situation is to compare the aggregate of the three classes of salaried personnel for 1935 (salaried officers, supervisory employees, and clerical, etc., employees) and 1937, and the two classes of salaried personnel for 1939 (salaried officers and salaried employees in manufacturing), with the British figures for salaried personnel. For the years 1937 and 1939 U S figures will be underestimated owing to the exclusion of central office personnel, which is included in the British data. Further, for 1939 U.S. figures will also be underestimated on account of the exclusion of personnel employed in distribution, construction and other jobs The inclusion of the latter categories in the 1939 U S figures, on the other hand, for purposes of comparison with the U.K perhaps overestimates the total number of persons employed

(vi) *The weighting of the different types of labour*

It would lead to an important refinement of our methods if, instead of aggregating all operatives without distinction, a weighted figure, expressed in 'men units', could be calculated The method usually available for weighting would be relative wages rates or hourly earnings, which tend to express broadly the differences between potential efforts. For obvious reasons this is not always the case, especially in a country like Britain with fairly strong delimitations of different kinds of jobs

Unfortunately data are not fully available for making such calculations, although we have attempted to indicate the effect of sex composition at least. (See Chapter III) The British *Census of Production* is more detailed than other *Censuses*, as it gives the number of males and females, those under 18 and over 18, but even these figures are not detailed enough, and the breakdown of age groups does not correspond to the usual groups distinguished in wage scales or in wages and earning statistics. For the U.S. it is the 1939 *Census* only which provides a breakdown of personnel by sex (in one week of the census year), but there are no further breakdowns for age groups.

In considering the importance of this factor, it should be borne in mind that it is a structural characteristic of the British economy that a higher proportion of the working population in general and of the manufacturing

personnel in particular are females. This is perhaps not unconnected with the fact that U.S. earnings are higher, and there is not so much economic necessity for women to go out to work. Apart from the structural factor, changes and shifts in the composition of the labour force are equally important.

(vii) *The year chosen for comparison*

The use of available capacity (both of machinery as well as of labour) appears to be one of the factors affecting output per head, as can be seen clearly in such cases as steel, cement, bricks, and so forth For this reason a comparison is relevant only if the years chosen in the countries to be compared are reasonably comparable as to the rate of unemployment and the use of capacity of equipment

As the purpose of this study is to compare productivity of labour in the pre-war period, the best year for comparison would be 1937, which year as can be seen from Table 12 was a relatively good year in both countries, the U K. and the U S.

Unfortunately the statistical material is not fully available in either country for this particular year. The most detailed collection of material for Britain is the 1935 *Census of Production*, for which year the last complete census was taken, and for the U.S. the 1939 *Census of Manufactures*. The best method appears to be, therefore, to start from these two base years and work backward in the case of the U S. and forward in the case of the U.K. Some British industries were covered by the Import Duties Act Inquiry for 1937, but by the outbreak of the war reports relating to textiles and iron and steel only had been compiled and published. Even for these industries however the 1935 *Census* gives many more details. For the U.S. the usual biennial *Census of Manufactures* covered both the years 1935 and 1937, and the detailed reports have been used for the purposes of this paper. But the 1939 *Census* —which formed part of the general decennial *Census* of the United States for 1940—is much more detailed than the 1935 and 1937 *Censuses* It deals with more subjects, such as size of plants, and horse-power statistics, and its industrial classification is also more detailed

In cases where the comparison—for statistical reasons—relates to different years, the tables in Chapter IV showing changes in time within the countries concerned gives a basis for adjustment.*

(viii) *The exclusion of small firms*

In comparing the results of the British and American *Censuses* it should be borne in mind that the scope of these two *Censuses* is not identical. For the British *Census* for 1935 and for the 1937 Import Duties Act Inquiry 'detailed returns were not obtained from persons employing not more than ten persons as a yearly average'; the excluded small firms gave only the average number of persons employed; while for the U.S *Censuses* data have been collected only

* A small point to be considered is the latitude given in the respective *Censuses* for returns which thus do not necessarily cover the calendar year The effect of this factor appears to be so small that no allowance for it is called for

from establishments reporting products to the value of \$5,000 per annum or more.* As the value of product per person engaged amounted to \$6,270 in 1937, the scope of the U.S. *Census* is wider than the British *Census* (except for repairs and 'custom' industries). In 1935, in the factory trades covered by the British *Census*, 536,600 persons were estimated to have been employed by small firms (with not more than ten employees) as compared with 5.2 million persons employed by firms with ten or more employees. In individual industries, of course, this ratio is even higher. For the U.S. the only indication of the excluded persons is given in the 1939 *Census of Service Establishments*, where persons employed in such categories as automotive repairs and services, other repair services, and especially custom industries are shown, categories which are broadly comparable to, although more extensive than, the excluded British small firms. But the number of persons employed in these services was relatively small in comparison with the 9·1 million persons employed by the census industries.

The effect of these differences in the scope of the *Censuses* on relative productivity depends on the relative efficiency of different-sized establishments and plants. Available evidence† suggests that small plants and small firms have a lower output per head than bigger plants, and thus their exclusion from the British *Census* makes the comparison more favourable for Britain than it would be by their inclusion.

(ix) *Output per man-hour versus output per man*

There are two alternative measurements of productivity: output per man and output per man-hour.

When measuring changes in productivity of labour in the purely technical sense or measuring costs of production, the 'output per man-hour' concept is the relevant one. For many other purposes, e.g. estimating man-power requirements, or future national incomes, comparing real incomes in different countries, etc., the output per man concept is more appropriate.

There are, however, further refinements to be considered in either case. On the one hand, in estimating output per worker, we may have in mind either the workers employed in producing the particular product who are on the books (i.e. colliery books or the books of cotton mills, etc.), or the workers on the pay-roll or the workers actually at work. Workers on the books may include people who have left the industry altogether, workers on the pay-roll will probably include those who are absent for part of the week, those who left during the week or were taken on during the week or those who went on holidays during the week, all of whom worked therefore only a part-week. Workers on the pay-roll may or may not include those on holiday for the

* The following establishments were, however, excluded from the U.S. *Census*: 'Those engaged principally in the performance of work for individual customers, such as repair shops, custom tailor shops, manufacturing products valued at less than \$100,000 within the census year, and dressmaking and millinery shops (but this does not apply to large establishments manufacturing to fill special orders).'

† See *Final Report of the 1930 Census*, Volume V, L. Rostas, *Productivity, Prices and Distribution in Selected British Industries*, N.I.E.S.R. Occasional Paper, XI, and J. M. Blair, 'The Relation Between Size and Efficiency of Business', *Review of Economic Statistics*, August 1942.

whole week. 'Workers actually at work' would exclude both the absentees and those on holidays and would make allowances for those working only for part of the week On the other hand, in estimating 'output per man-hour' there will be differences between productive hours and hours actually paid, which latter, at least for time-workers, include payment of time spent in meal-breaks and other non-productive time. The widest concept is 'output per man-year', inclusive of absentees and those on holidays, and this is the most useful concept when estimating national incomes or labour requirements In measuring productivity in the technical sense, output per workers actually at work or output per productive man-hours (the latter being the narrowest concept) are relevant, while in measuring costs of production 'output per man-hours actually paid for' is perhaps the appropriate concept

Available statistical information does not allow all these refinements to be taken into account, of course, and the man-hour data are especially imperfect in measuring actual hours worked in the year Employment data in the *Censuses of Production*, on which most of the calculations in this study were based, are probably nearer to the concept of 'workers on the pay-roll' than to the concept of 'workers actually at work'. Number of workers is usually ascertained in one pay week in each month and thereby can be regarded as a reliable yearly average.

The data on actual hours worked are not based on the *Censuses of Production*, but on special enquiries by the Ministry of Labour (for 1906 by the Labour Department of the Board of Trade) in the U.K and by the Bureau of Labor Statistics in the U S.

In Britain *actual* hours of work for a very large sample of workers have been ascertained for one week in 1906, 1924, 1935 and 1938, and twice yearly since 1940.* The 1924 and 1935 statistics allowed for short-time and overtime working, but do not allow for loss of time by individual workers due to voluntary absence from work, sickness, bad time-keeping, etc , all of which tend to reduce average actual hours

For the U S monthly data have been collected for all years under review, 'supplied by co-operating establishments covering both full- and part-time wage-earners' Thus the U S average for the year based on twelve-monthly data is more reliable than the British figures relating to one week in the year. But neither of these figures enables us to estimate the total number of man-hours worked in the year without making some guesses as to the actual number of working weeks

In both cases the data are nearer to the concept of 'hours paid for' than to productive hours It is indeed unlikely that we can measure output per productive hours on the basis of data collected for other purposes than direct productivity comparisons

When making productivity comparisons, whether in time or internationally, one further point has to be considered Shorter hours of work may be due to unemployment and the spreading of work over a larger number of workers; or they may mean a genuinely shorter working week, in the sense that the

* See *Ministry of Labour Gazette*, 1926-7, 1933, 1937, and *passim*, and the volumes on the *Hours and Earnings Inquiry*, 1906, published by the Board of Trade, 1909-13

workers take part of their real earnings in increased leisure This differentiation is especially important owing to the *prima facie* causal relationship between the number of hours worked and output per man-hour A number of studies made by industrial psychologists have indicated that unduly long hours of work reduce output,* at the same time it is held that the relatively higher output per man-hour in the U S. is made possible to some extent by shorter working hours, or in other words that the mass-production methods employed in the U S could not be operated permanently by operatives working long hours. If this argument is true, and it requires careful investigation, it would mean that the U.S. and the U.K per man comparisons are perhaps more realistic than per man-hour comparisons, and further that it would not be possible in Britain both to have higher output as well as maintaining longer working hours, since higher output per man-hour could be achieved only by a shorter working week

* See Chapter V, section 4

CHAPTER III

PRODUCTIVITY COMPARISONS IN BRITISH AND AMERICAN MANUFACTURING INDUSTRY

1. A GENERAL COMPARISON IN INDUSTRY

A comparison of output and employment in 31 manufacturing industries shows that in the pre-war period of 1935–9 average productivity—as measured by physical output per worker—was at least twice (about 2 2 times) as high in the U.S. as in Britain. If allowance is made for the shorter working week in the U S , output per man-hour was perhaps 2 8 times as high in the U S as in Britain

The 31 industries included in this comparison together accounted for about

Table 1. *Comparison of physical output per worker and per man-hour in the selected manufacturing industries*, 1935–9 *General results*

All industries covered by sample	Output per worker			Output per man-hour*		
	U K	U S including machinery trade	U S excluding machinery trade	U K	U S including machinery trade	U S excluding machinery trade
Unweighted (*a*)	100	216	214	100	287	284
(*b*)	100	224	223	100	292	290
Weighted with British employment (*a*)	100	212	199	100	273	257
(*b*)	100	215	203	100	275	261
Weighted with U S employment (*a*)	100	215	203	100	275	261
(*b*)	100	218	206	100	277	264

Notes (*a*) Comparing as far as possible the same years (mostly 1935) in both countries (*b*) Comparing years which reflect more closely the same degree of use of capacity (i e either 1937 in both countries, or 1935-37-39 average in U S with 1935 in U K).

* These columns cover a smaller number of industries

half of the value of net output in Britain and two-fifths of the value of net output in U.S manufacturing industry, broadly speaking, consumption goods industries were better represented in the sample than capital goods industries.

A comparison of the value of net output per worker in the two countries for all manufacturing industries (for which purpose the U.S. net output has been converted into £'s sterling at the official rate of exchange) largely confirms the results of a comparison of physical output per worker in the selected 31 industries (see Table 2).

The average difference between the U S and U.K will vary somewhat according to the method of weighting (reflecting differences in industrial structure) or the actual year chosen for comparison (reflecting use of capacity), and on account of a number of other factors.

Table 2 *The value of net output per head of operatives in the United Kingdom, Germany, and the United States*

(in £, and in index numbers)

Trade	United Kingdom 1935		Germany 1936		United States 1937	
	£	Index Nos	£	Index Nos.	£	Index Nos
Iron and steel	239	100	291	122	596	249
Engineering, motor, ship-building	270	100	339	126	686	254
Non-ferrous metal	283	100	403	142	642	227
Chemicals	617	100	651	106	1,145	186
Textiles	159	100	205	129	318	200
Clothing	168	100	218	130	356	212
Leather	237	100	270	114	417	176
Rubber	312	100	341	109	575	184
Clay and stone	238	100	195	82	588	247
Timber	215	100	192	89	369	172
Paper and printing	332	100	260	78	867	261
Food, drink, and tobacco	487	100	417	86	760	156
Miscellaneous	270	100	256	95	575	213
Total factory trades	264	100	294	111	595	225

Note. Computed from production census data Rates of conversion used were $4 94 to the £ and Rm 17 08 to the £ It must be emphasized that the conversion rates were chosen to correspond to relative purchasing power in terms of commodities in general, and not (or not necessarily) in terms of the products of the individual industrial groups To the extent that the purchasing power parity in terms of these individual groups would yield different results, the figures in the above table must be considered arbitrary

2. VARIATIONS IN THE GENERAL COMPARISON

(i) *Industrial structure*

By weighting differences in productivity in individual industries by the relative importance of these industries in the U.S , the U S advantage in average productivity is slightly higher, owing to the fact that the industries in which the U S. advance in productivity is high have a more important position in American industry than they have in British But the differences on this account are relatively small and the higher American productivity cannot be explained except to a small extent by differences in industrial structure. In any case, as can be seen from Table 10, the differences in industrial structure

—in terms of the proportionate importance of net output or of employment in the U.K and U S —are not great.

It should be remembered, however, that our comparison covers not more than half of the output and only about 31 industries, while both *Censuses* distinguish well over 100 individual industries Such important industries as ship-building, non-ferrous metals, timber, heavy chemicals, petroleum refining (in the U.S), tailoring, printing, leather, were not included in the sample A comparison of the value of net output per worker for the main industry groups—as shown in Table 2—includes, of course, all manufacturing industries This comparison does not suggest, however, that our results would be different if more industries were included in our comparison of physical output per worker

(ii) *The year chosen for comparison*

Another factor which affects the comparison is the year chosen for comparison Unfortunately data for 1937, which would reflect approximately equal use of capacity of capital and labour resources, are available for comparison in a few industries only Therefore, two sets of comparisons have been made. (*a*) a comparison for identical years, taking the last identical year for which data are available in both countries, i e in most cases 1935, (*b*) a comparison relating to years reflecting, broadly speaking, similar use of capacity, i e. data for 1935 in Britain were compared with an average for 1935–7–9 in the U.S , unless direct comparison of years more recent than 1935—which is unrepresentative for the U S.—could be made. The comparison by the first method gives an index of output per worker of 212–215 for the U S , the U K. being 100, while the second method gives an index of output per worker of 215–218 for the U.S. Thus the differences are relatively small.

(iii) *The average length of the working week*

A third factor which affects a comparison of productivity is the difference in average working hours per week The difference in productivity on this account is substantial, owing to the fact that in the U K. manufacturing industry in general actual working hours in the week ended 12 October 1935 amounted to 47 8, while in the U S it was 36 6 hours in 1935, 38 6 hours in 1937, and 37 7 hours in 1939 The British worker works on the average 27% more hours than the U.S worker, and consequently the relative output per man-hour in the U S. is about 27% higher than relative output per worker in the U.S as compared with the U K

(iv) *The ratio of salaried staff to workers*

A comparison of output per worker or per man-hour does not take into account differences in the proportion of salaried persons employed. Higher output per worker may be achieved by reducing the number of operatives and increasing simultaneously the number of administrative or technical staff. It is, in fact, argued that higher mechanization will lead to more paper work and planning—executed by salaried personnel—and that thus a reduction in

operatives (i e an increase in output per worker) will be to a certain extent counterbalanced by an increase in salaried persons.*

Unfortunately, British and American data on salaried personnel are not quite comparable, thus the theoretical question cannot be answered satisfactorily. But within the limits of available statistics, the effect of differences in the ratio of salaried staff to operatives in the two countries on productivity comparisons can be indicated.

There were employed per 100 operatives in the U.K. and the U.S. the following numbers of salaried persons

U.K	1935	15 0	salaried persons
U.S	1935	14 7	,, ,,
		15 8*	,, ,,
U S.	1937	14 2	,, ,,
		15 6†	,, ,,
U.S	1939	16 9*†	,, ,,
		20 0‡	,, ,,
		21 4‡	,, ,,

* Including proprietors and members of the firm.
† Including persons employed by central administrative offices.
‡ Includes salaried officers of corporations, and all other salaried employees, whether engaged in manufacturing, in distribution, in construction or in other work Refers to employees receiving pay at any time within the normal pay-roll period ended nearest 14 October 1939 See Table I of Chapter III, Vol. I, *U S Census of Manufactures*, 1939

In all periods considered, except in 1939, when the scope of the U S. *Census* was changed, the ratio of salaried personnel to operatives was, broadly speaking, the same in the two countries. But even if we take the 1939 ratio, the effect of this difference on productivity comparisons is small. On this basis the ratio of output per employee would be perhaps 4–5% lower in the U.S than output per worker. There may be, of course, somewhat wider divergences between output per employee and output per worker in individual industries.

(v) *Inclusion of non-manufacturing staff*

(*a*) It may be argued that differences in productivity between the two countries may be affected by a different definition of the labour force, and especially by the inclusion in the British employment data of persons who are employed in non-manufacturing activities The importance of this factor for productivity comparisons on account of persons employed in distribution and in construction can be seen from the figures in the previous section.

All those persons who were classified in the previous section as salaried

* This hypothesis applies, of course, with equal or even greater force to a comparison of productivity of different firms within the same industry of any one country In fact there appears to be some truth in this hypothesis, if applied to different-sized firms in some selected British industries See Rostas, *Productivity, Prices and Distribution in Selected British Industries*, op cit , Appendix 4

The thesis that higher output per worker (due to higher capital intensity) is associated with a replacement of operatives by salaried personnel also applies to the replacement of direct workers (i e workers operating the machines and handling the job) by indirect workers (maintenance workers, draughtsmen, workers concerned with planning production, etc) This highly important aspect of the problem cannot be investigated within the framework of available statistics, as *Censuses of Production* do not distinguish between direct and indirect labour.

personnel for 1939 in the U S , include in fact all personnel (with the exception of workers in manufacturing) employed in construction, in distribution and in other non-manufacturing work Thus a comparison of all persons employed by manufacturing establishments in the U S with all persons (operatives and salaried) employed by British industry—as shown above—also indicates that the potential inclusion of non-manufacturing personnel, notably those engaged in distribution, in the figures for the labour force has a small effect on productivity comparisons.

There are one or two other cases which would fall into the same category, although it is not possible to indicate their quantitative importance

(*b*) We shall see that the amount of energy used may differ in two countries Quite apart from those differences, the way in which this energy is generated may also differ, and it is the latter difference with which we are concerned here. In the U.S a larger proportion of the energy consumed is in the form of purchased electricity. In Britain, on the other hand, a larger proportion of energy is applied mechanically (i e directly for prime-movers), and in addition a larger proportion of electricity used is generated in the firm's own works, than is the case in the U S.* Those employed in operating these prime-movers and electric generators, where in America purchased electricity is used, will appear in the total labour force of British manufacturing industry To this extent they will make British-American comparisons less favourable, although the effect of this factor is probably small

(*c*) A third case arises from the fact that raw materials are received in certain British industries in a less prepared stage than in the equivalent American industries. Thus an additional process is needed which, say, in Britain is done by the employees of the manufacturing industry in question, whereas in the U S it is done by the employees of the raw-material industry For example, the process of removing the midrib from tobacco leaves is undertaken for the U.S tobacco industry in re-handling factories to a greater extent than is the case in factories preparing leaf for the United Kingdom market It follows that an additional factory operation is undertaken in U.K factories while that operation in the U S factories is far less significant Another example is the cleaning of iron ore, or the sorting of wool Again, the importance of this factor for industry as a whole is probably small.

(vi) *The composition of the labour force: proportion of males to females*

It is a fundamental difference between the British and American economy that a higher proportion of females of working age works in Britain, and consequently a higher proportion of the labour force in industry consists of females. It is of interest to assess the effect of this factor on comparative productivity † In order to have some idea of the magnitude of the difference on this account labour force data in the two countries were converted as a

* In 1930 in the U K 66 2% of all power was in the form of electricity, in the U S. in 1929 it was 79%, and in 1939 it was 85% In addition, in 1935 in the U K 56 4% of electricity was purchased, in the U S in 1939 61% was purchased

† It is of interest to note that none of the U S productivity enquiries treat males and females differently, and this is justified by the fact that the same rate is paid for the same job irrespective of whether it is a man or a woman worker who is doing the job

rough approximation into 'equivalent men' on the basis of average relative earnings. In the U.K. earnings of females are approximately half as high as the earnings of males. In the U.S. earnings of females appear to be about six-tenths of the earnings of males.*

Using the latter ratio (i.e. counting each woman worker as 0·6 equivalent man) the following figures are arrived at.

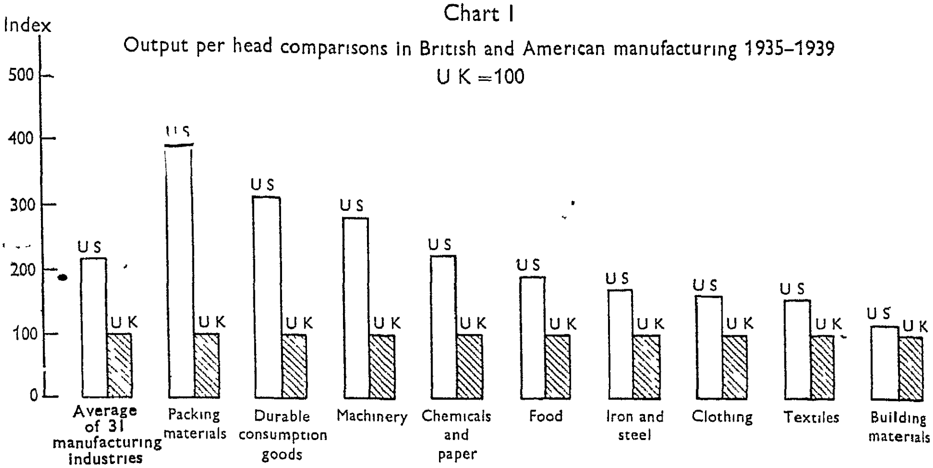
Table 3. *The composition of the labour force in U.K. and U.S. manufacturing*

Industry	Proportion of men in the total labour force		Equivalent men as proportion of total labour force		Ratio of U.S./U.K. labour force irrespective of sex	Ratio of U.S./U.K. labour force in equivalent men
	U.K. (1935)	U.S. (1939)	U.K. (1935)	U.S. (1939)	U.K.=1	U.K.=1
Total labour force	62·5	74·2	85·0	89·7	1·94	2·04
(1) Blast furnaces	99·8	99·9	99·9	100·0	1·60	1·63
(2) Steel	99·3	99·0	99·7	99·6	3·30	3·34
(3) Foundries	94·4	99·1	97·8	99·6	1·36	1·39
(4) Mechanical engineering	94·9	94·7	98·0	97·9	1·48	1·48
(5) Cement	99·4	99·7	99·7	99·9	3·13	3·14
(6) Brick	95·2	99·9	98·1	100·0	3·68	3·75
(7) Coke	99·8	99·9	99·9	100·0	1·93	1·93
(8) Seed crushing	96·8	98·7	98·7	99·5	2·79	2·82
(9) Cotton	35·2	61·2	74·1	84·5	1·30	1·48
(10) Woollen and worsted	41·2	60·4	76·5	84·1	0·83	0·92
(12) Linoleum and oilcloth	93·0	97·3	97·2	98·9	1·09	1·11
(13) Paper	75·6	90·5	90·2	96·2	2·13	2·27
(17) Motor-cars	84·4	93·4	93·8	97·4	2·32	2·41
(20) Boots and shoes	56·2	54·9	82·5	82·0	2·08	2·06
(21) Hosiery	19·6	36·0	67·8	74·4	2·37	2·60
(22) Breweries	92·4	99·5	96·9	99·8	0·81	0·84
(23) Tobacco	27·5	33·1	71·0	73·2	2·55	2·63
(24) Soap	50·3	83·0	80·1	93·2	0·72	0·84
(26) Matches	39·2	57·7	56·0	83·1	1·68	1·84
(27) Biscuits	29·8	49·8	71·9	79·9	0·82	0·91
(29) Grain milling	93·4	98·2	97·4	99·3	1·12	1·14
(30) Fish curing	40·8	66·9	76·3	86·8	0·52	0·59
(31) Manufact'd ice	99·7	99·9	99·9	100·0	10·83	10·84

It appears that on an 'equivalent man' basis, the ratio of productivity for industry as a whole would be about 10% less favourable to the U.S. It would make little difference in the metal, engineering or building materials industries,

* Comparison of earnings of males and females also reflects, of course, the ratio of juveniles to adults in both categories. When 'equivalent men' data are calculated, it would be obviously more precise to distinguish between juveniles and adults or even the different categories of juveniles. Unfortunately, no data are available in the U.S. for comparison with the British data given in the *Hours and Earnings Inquiries*. The other important point is that the ratio for manufacturing industry as a whole reflects differences in earnings in different industries and different jobs as well as differences in the earnings of men and women doing the same sort of work.

but it would reduce the U S superiority in the textile industries (cotton, wool, and hosiery) as well as in the biscuit, paper, match, soap, and tobacco trades



3. COMPARISON OF INDIVIDUAL INDUSTRIES

Grouping the individual industries for which productivity comparisons were computed by type of product, we find (as shown in Table 4 and Chart I) that relative output per worker or per man-hour is highest in those U S. industries producing packing materials (e.g tin cans) and durable, mass-produced consumption goods (e g motor-cars), i e in industries where the scope of automatic machines is great Relative productivity is above the average in the machine-producing industry (although this is based on a value comparison) Relative productivity is on the average level for chemicals and paper, slightly below the average for the food industries, and well below the average for iron and steel, clothing, textiles, and building materials

Table 4 *Comparison of output per head in main groups of industry in* 1935–9

(U K =100)

	U S. 1935–39
Comparison of productivity in 31 sample industries	212-224
Higher than average advance in U S productivity	
Packing materials (glass containers, tin cans)	394-402
Durable mass-produced consumption goods (motor-cars, wireless sets)	310-312
Machinery	280
Less than average advance in U S productivity	
Seed crushing, rayon, soap, matches, paper	224-225
Manufactured food	193-197
Iron and steel	173-174
Clothing	159-163
Textiles	155-160
Building materials	113-125

Taking individual industries, U S output per worker or per man-hour is highest relatively to British output in the tin can, wireless sets, motor-car, biscuits, soap, rubber tyres, glass container, and paper industries, and lowest in the fish-curing, cement, seed-crushing, and beet-sugar industries In no industry covered by the comparison is output per man-hour lower in the U S. than in the U.K , and in two industries only, in cement and fish-curing, is output per worker higher in the U K than in the U S

4. COMPARISON OF VALUE OF NET OUTPUT PER WORKER

The value of net output per worker in the U K. and U.S has been worked out for practically all the individual industries for which comparisons of physical output per worker have been made. In converting the U S values to £'s sterling at the official rate of exchange, i e on the assumption that the ratio of prices in the individual industries is the same as the ratio of general price levels,* the relative value of net output per worker can be compared with the relative physical output per worker in the two countries This comparison shows that in 19 industries out of 30 for which such a comparison is possible, there is a close, or fairly close, parallel between the ratio of the value of output per worker and of physical output per worker. These industries are: pig iron, steel, paper, breweries, biscuits, ice, also foundries, cement, brick, coke, seed crushing, cotton, rayon weaving, glass containers, boots and shoes, hosiery, soap, grain milling, and rubber tyres In all these cases, except the first six and the last, the ratio of the value of output per worker is higher than the ratio of physical output per worker In the case of rubber tyres the opposite is true. In six industries, wool, rayon making, jute, linoleum, beet sugar, fish curing, the value comparison shows an appreciably greater advantage for the U.S than for the U K. In five cases, tin cans, motor-cars, wireless sets, tobacco, and matches, the physical comparison shows an appreciably greater advantage for the U S. than for the U K These divergencies in the two measurements require further investigation They may be due to the fact that price ratios in these industries differ from the ratio of the general price levels as expressed in the official rate of exchange; thus, in the six industries where the value comparison shows a greater U S advantage British prices are relatively lower, while in the four industries where the physical comparison shows the greater U.S advantage, U S prices are relatively lower These divergencies may also indicate, of course, differences in the type and quality of the products in the two countries.

5. SOME DATA RELATING TO COMPARISON OF PRODUCTIVITY OF LABOUR IN THE U.K., U.S., GERMANY, SWEDEN AND HOLLAND

Output per worker in British manufacturing industry compares more favourably with output per worker in Continental industrial countries than with productivity of labour in the U S A preliminary comparison of output per

* This assumption diminishes, of course, to a substantial extent the value of comparisons of net output per worker Only if conversion rates in terms of the products of the individual industry groups could be used, which unfortunately are not available, would these indices provide a check on the comparisons of physical output per worker

worker* in a number of industries in Germany, Sweden, and Holland shows that productivity of labour is on the average approximately the same in these countries when compared with Britain

As between Britain and Germany, the German advantage is more marked in the capital goods industries such as iron and steel. Germany is greatly inferior, however, in some food trades such as preserved foods and breweries.

As between Britain and Sweden, the comparison relates to eight industries only and does not cover such important industries in Sweden as iron ore mining, pulp making, or timber Sweden appears to have higher productivity of labour in making paper, pipe tobacco and snuff; she is on the British level in making margarine, and below the British level in grain milling, cement, cotton weaving, boots and shoes and cigarettes.

As between Britain and Holland the comparison covers six industries only Holland appears to have higher labour productivity in soap and cement making and lower labour productivity in brick making, breweries, margarine, and rayon

* These comparisons are more approximate than the U K -U S comparisons and require further investigation

Table 5 *Estimated output per worker in U K and U.S*
(index numbers)

For degree of reliability of estimates see notes on individual industries

	United Kingdom		United States		
	1935	1937	1935	1937	1939
(1) Pig iron	—	100	—	364	—
(2) Steelworks and rolling mills, including wire and wire products	—	100	—	166	—
(1)-(2*a*) Blast furnaces, steelworks and rolling mills, including wire and wire products	—	100	—	171	—
(1)-(2*b*) Blast furnaces, steelworks and rolling mills, excluding wire and wire products	—	100	—	174	—
(3) Foundries, iron and steel	100	—	150	167	177
Cast-iron pipes and fittings	100	—	140	155	173
Malleable castings	100	—	—	234	236
Other iron foundries	100	—	(152)	(170)	167
(4) Machinery*	100	—	—	268	310
(5) Cement‡	—	100†	—	94	110
(6) Brick	100	—	121	(139)	(150)
(7) Coke	100	—	(187)	236	190
(8) Seed crushing	100	—	—	—	117
(9) Cotton spinning and weaving	—	100	—	—	175
Cotton spinning	—	100	—	—	150
,, weaving	—	100	—	—	200
(10) Woollen and worsted	—	100	—	130-140	—
Woollen	—	100	—	145-153	—
Worsted	—	100	—	115-120	—
(11) Rayon rayon making	—	100§	—	—	143
,, weaving	—	100	—	149	—
(12) Linoleum and oilcloth	100	—	—	(191)	148-184
(13) Paper	100	—	(224)	(249)	263
(14) Rubber tyres	100	—	(271)	276	315
(15) Tin cans	—	100	—	525	—
(16) Glass containers	100	—	(242)	(266)	276
(17) Motor-cars	100	—	306	—	—
(18) Wireless sets	100	—	—	—	348
(19) Electric lamps	100	—	—	—	539-548
(20) Boots and shoes	100	—	141	142	145
(21) Hosiery	—	100	—	—	161‖
(22) Breweries	100	—	201	202	250
(23) Tobacco ** Cigarettes	—	—	—	—	—
Pipe tobacco	—	—	—	—	—
Cigars	—	—	—	—	—
(24) Soap	100	—	266	286	328
(25) Margarine	100	—	120	153	172
(26) Matches	100	—	312	336	331
(27) Biscuits	100	—	(310)	(347)	363
(28) Beet sugar	100	—	(102)	(108)	117-123
(29) Grain milling	100	—	(167)	174	—
(30) Fish curing	100	—	—	—	54
(31) Manufactured ice	100	—	207	219	256

* Based on comparison of the value of net output per worker
† 1938
‡ For U K, 1935=100, U S, 1935=81
§ 1939
‖ On U K =1935 basis, U S =176
** See Part II, Section I, Appendix 23

Note Figures in brackets largely based on extrapolation with the help of available indices on changes in output per worker

Table 6 *Estimated output per worker in U K and U.S*
(Physical quantities)
For degree of reliability of estimates see notes on individual industries

	United Kingdom		United States		
	1935	1937	1935	1937	1939
(1) Pig iron (tons)	—	458	—	1,667	—
(2) Steelworks and rolling mills, including wire and wire products (tons)	—	44	—	73	—
(1)-(2*a*) Blast furnaces, steelworks and rolling mills, including wire and wire products (tons)	—	41	—	70	—
(1)-(2*b*) Blast furnaces, steelworks and rolling mills, excluding wire and wire products (tons)	—	46	—	80	—
(3) Foundries iron and steel					
Cast-iron pipes and fittings (tons)	37 7	—	52 6	58 4	65 2
Malleable castings (tons)	8 1	—	—	19 0	19 2
Other iron foundries (tons)	21 0	—	(31 9)	(35 7)	35 1
(4) Machinery		Not available			
(5) Cement (tons)	793	837*	646	786	922
(6) Brick (th equivalent common bricks)	162	—	196	—	—
(7) Coke (tons)	962	—	—	2,270	1,824
(8) Seed crushing (tons)	224	—	—	—	263
(9) Cotton spinning (lb yarn)	9,210	9,770	—	—	14,700
Cotton weaving (sq yds of cloth)	27,320	29,990	—	56,900	60,300
(10) Woollen and worsted			Not available		
(11) Rayon making (lb)	3,930	6,280†	—	7,320	9,000
Rayon weaving (lb)	2,000	2,580	3,000	3,850	5,110
(12) Linoleum and oilcloth			Not available		
(13) Paper (tons)	43 5	—	—	—	114 9
(14) Rubber tyres			Not available		
(15) Tin cans (th cans)	—	95	—	546	—
(16) Glass containers (th gross)	754	—	—	—	2,067
(17) Motor-cars (cars)	2 86	—	8 76	—	—
(18) Wireless sets	—	Not available		—	—
(19) Electric lamps (th bulbs)	15	—	—	—	79
(20) Boots and shoes (pairs of equiv men's shoes)	885-964	—	1,357	1260-1372	1,420
(21) Hosiery			Not available		
(22) Breweries (th barrels)	433	—	872	873	1,083
(23) Tobacco †					
Cigarettes	—	—	—	—	—
Pipe tobacco	—	—	—	—	—
Cigars	—	—		—	—
(24) Soap (cwt)	797	—	2,120	2,275	2,613
(25) Margarine (th lb)	185	—	217-226	281-286	306-331
(26) Matches (millions)	23 3	—	72 6	78 2	77 2
(27) Biscuits (cwt)	134	—	—	—	487
(28) Beet sugar (th cwt of refined sugar)	2 45	—	—	—	2 80
(29) Grain milling (tons)	377	—	—	653	—
(30) Fish curing (cwt)	814	—	—	—	439
(31) Manufactured ice (tons)	750	—	1,554	1,644	1,925

* 1938 † 1939

† See Part II, Section I, Appendix 23

Note Almost all figures are rough approximations

Table 7. *Estimated output per man-hour in U K and U S*
(index numbers)
For degree of reliability of estimates see notes on individual industries

	United Kingdom		United States		
	1935	1937	1935	1937	1939
(1) Pig iron	—	100	—	452	—
(2) Steelworks and rolling mills, including wire and wire products	—	100	—	207	—
(1)-(2*a*) Blast furnaces, steelworks and rolling mills, including wire and wire products	—	100	—	215	—
(1)-(2*b*) Blast furnaces, steelworks and rolling mills, excluding wire and wire products	—	100	—	215	—
(3) Foundries iron and steel	100	—	—	—	230
(4) Machinery*	100	—	—	340	—
(5) Cement‡	—	100†	—	121	144
(6) Brick	100	—	159	—	—
(7) Coke		Not available			
(8) Seed crushing	100	—	—	—	125
(9) Cotton spinning and weaving	—	100	—	—	200-210
Cotton spinning	—	100	—	—	161-172
Cotton weaving	—	100	—	—	250-260
(10) Woollen and worsted	—	100	—	174-188	—
(11) Rayon rayon making	—	100§	—	—	167
rayon weaving	—	100	—	195	—
(12) Linoleum and oilcloth		Not available			
(13) Paper	100	—	(281)	(295)	315
(14) Rubber tyres	100	—	(422)	422	437
(15) Tin cans	—	100	—	650	—
(16) Glass containers	100	—	(318)	(349)	366
(17) Motor cars	100	—	396	—	—
(18) Wireless sets	100	—	—	—	414
(19) Electric lamps		Not available			
(20) Boots and shoes	100	—	187	186	192
(21) Hosiery	100	—	(209)	(211)	234
(22) Breweries	100	—	—	255	310
(23) Tobacco Cigarettes	100	—	212-246	—	—
Pipe tobacco	100	—	722-756	—	—
Cigars	100	—	278-287	—	—
(24) Soap	100	—	334	343	393
(25) Margarine		Not available			
(26) Matches		,,	,,		
(27) Biscuits	100	—	—	—	424
(28) Beet sugar		Not available			
(29) Grain milling	100	—	—	—	197
(30) Fish curing		Not available			
(31) Manufactured ice		,,	,,		

* Based on comparison of the value of net output per worker
† 1938
‡ For 1935, U K = 100, U S = 122
§ 1939

Note Figures in brackets are largely based on extrapolation with the help of available indices on changes in output per worker

Table 8. *A comparison of the value of net output per worker in the U K and the U S.**

	The value of net output per worker								The value of net output per worker in U S in index no			Physical output per worker in U S (in index numbers)‡		
	(U K in £)		(U S in $)			(U S in £†)			(U K = 100)			(U K = 100)		
	1935	1937	1935	1937	1939	1935	1937	1939	1935	1937	1939	1935	1937	1939
1) Pig iron	—	373	—	5,531	—	—	1,120	—	—	300	—	—	364	—
2) Steelworks and rolling mills	—	337	—	3,142	—	—	636	—	—	189	—	—	166	—
3) Iron foundries	209	—	1,772	2,118	2,400	362	429	541	173	205	259	150	167	177
4) Machinery	275	—	—	3,646	3,790	—	737	854	—	268	310	Not available		
5) Cement	697	—	3,736	4,284	5,213	762	867	1,174	109	124	168	—	94	101
5) Brick	230	—	—	1,654	1,915	—	335	431	—	146	187	121	—	—
7) Coke	323	—	—	4,096	3,950	—	829	890	—	257	276	—	236	190
8) Seed crushing	454	—	—	—	2,863	—	—	645	—	—	142	—	—	122
9a) Cotton spinning 9b) Cotton weaving	—	146	—	1,329	—	—	269	—	—	184	—	—	—	175
o) Woollen and worsted	—	191	—	1,826	—	—	370	—	—	194	—	—	130-140	—
1a) Rayon industry	225	—	2,386	3,159	3,488	579	639	786	267	284	349	—	—	143
1b) Rayon weaving	158	—	—	1,410	1,462	—	285	329	—	180	208	—	149	—
2) Linoleum and oilcloth	419	—	—	—	5,425	—	—	1,211	—	—	289	—	—	148-184
3) Paper	309	—	—	—	3,624	—	—	816	—	—	264	—	—	263
4) Rubber tyres	392	—	—	3,302	4,268	—	668	961	—	170	245	—	276	315
5) Tin cans	—	182	—	3,430	—	—	694	—	—	381	—	—	525	—
6) Glass containers	260	—	—	—	3,821	—	—	861	—	—	331	—	—	276
7) Motor-cars	288	—	2,893	3,094	3,313	590	626	746	205	217	259	306	—	—
8) Wireless sets	249	—	2,172	2,542	2,988	443	514	673	178	206	270	—	—	348
o) Boots and shoes	162	—	1,534	1,634	1,588	313	331	358	193	204	221	141	142	145
1) Hosiery	163	175	—	—	1,509	—	—	340	—	—	194§	—	—	161
2) Breweries	927	—	7,150	7,130	10,060	1,459	1,443	2,265	157	155	244	201	202	250
4) Soap	644	—	7,164	8,290	10,396	1,462	1,678	2,341	227	261	363	266	286	327
6) Matches	448	—	2,246	2,031	2,115	458	411	476	102	92	106	312	336	331
7) Biscuits	252	—	—	—	4,070	—	—	916	—	—	363	—	—	363
8) Beet sugar	289	—	—	—	4,749	—	—	1,069	—	—	370	—	—	117-123
9) Grain milling	522	—	—	5,809	—	—	1,176	—	—	225	—	—	174	—
o) Fish curing	203	—	—	2,741	2,453	—	555	552	—	273	272	—	54	—
1) Manufactured ice	493	—	5,270	5,827	6,549	1,075	1,180	1,475	218	239	299	207	219	256

* The indices of value of net output per worker are not strictly comparable with the indices of physical output per worker The former relate to the nearest production census group and not to the product (i e it includes all by-products but excludes that part of the main product produced outside the industry, etc.)

† The following official rates of exchange have been used· 1935 £1=$4 90, 1937 £1=$4 94, 1939 £=$4 44

‡ For degree of reliability of estimates see notes on individual industries.

§ On basis of U K , 1937=100

Table 9 *Comparison of physical output per worker in Sweden, Holland, Germany, and U K*

(U K =100)

	Germany (1936)	Sweden (1937)	Holland (1937-8)
(1)-(2) Pig iron, steelworks and rolling mills	141	—	—
(3) Iron and steel foundries	120	—	—
(4) Machinery	110	—	—
(5) Cement	92	90	170
(6) Brick	—	—	86
(7) Coke	152	—	—
(9*a*) Cotton spinning	120	—	—
(9*b*) Cotton weaving	68	84	—
(11) Rayon and silk	132	—	81
(12) Jute	106	—	—
(13) Paper	—	140	—
(14) Rubber tyres	117	—	—
(17) Motor cars	98	—	—
(18) Wireless sets	70	—	—
(20) Boots and shoes	110	68	—
(21) Hosiery	92	—	—
(22) Breweries	67	—	90
(23) Tobacco Cigarettes			—
Pipe tobacco	30	*	—
Cigars			—
(24) Soap	117	—	228
(25) Margarine	81	100	62
(28) Beet sugar	34	43	—
(29) Grain milling	93	95	—
Average of industries			
(*a*) unweighted	97	97	119
(*b*) weighted with U K net output	107	107	1[illegible]3
(*c*) weighted with own net output	101	99	150

* See Part II, Section I, Appendix 23

Notes German indices are quoted from *The Economic Journal*, April 1943, except for steel A revision of these figures could be undertaken when the detailed reports of the 1936 German census of production become available in this country

The Swedish figures were based on compilations by the Swedish Institute of Industrial Research

The Dutch figures were based on compilations by the Dutch Central Statistical Office

Table 10 *The structure of manufacturing production in the U K , U S and Germany*

Proportionate importance of different branches of industry in total output and employment*

(Percentages)

Trade	United Kingdom 1935	Germany 1936	United States 1935	United States 1937	United Kingdom 1935	Germany 1936	United States† 1935	United States† 1937
	Net output				Employment			
Iron and steel	9 9	16 5	11 2	13 6	10 6	16 1	12 2	13 6
Engineering, shipbuilding, and vehicles	21 0	21 4	18 3	21 3	21 4	19 4	16 1	18 4
Non-ferrous metal	2 5	2 4	3 1	3 4	2 4	1 8	3 0	3 2
Chemicals	7 4	9 9	9 8	9 5	3 8	5 0	5 2	4 9
Textiles	13 3	11 0	8 0	7 2	20 5	15 2	15 1	13 4
Clothing	6 9	4 0	7 7	6 3	10 4	5 6	11 5	10 5
Leather	0 9	1 0	1 4	1 1	0 9	1 5	1 5	1 4
Rubber	1 2	1 0	1 7	1 5	1 1	0 9	1 6	1 5
Clay and stone	4 5	6 7	3 2	3 5	4 8	9 5	3 2	3 5
Timber	3 2	4 0	4 7	5 0	3 8	6 1	8 0	8 1
Paper and printing	9 5	5 7	11 8	10 5	7 9	6 4	7 5	7 2
Food, drink and tobacco	17 0	14 0	16 5	14 6	10 1	10 2	12 3	11 4
Miscellaneous‡	2 5	2 4	2 6	2 5	2 4	2 3	2 8	2 9
Total factory trades	100 0	100 0	100 0	100 0	100 0	100 0	100 0	100 0

* Computed from census of production data German and American data were regrouped to cover British categories

† Based on number of operatives

‡ Includes scientific instruments, games, toys, sports requisites, etc

CHAPTER IV

CHANGES IN PRODUCTIVITY IN BRITISH AND AMERICAN MANUFACTURING INDUSTRY (1907–39)

One of the reasons why productivity of labour in manufacturing is higher in the U.S. than in the U.K. is the higher rate of increase in productivity per annum during the last generation. The trend in changes in productivity and rate of increase per annum is a major problem in itself, in many ways even more important than comparative productivity, although they are, of course, interconnected. Lower British productivity as compared with other countries may affect our competitive power abroad, and this will have serious repercussions in our economic system, but as long as the rate of progress is satisfactory it may not have as serious consequences for the national economy as a whole as would a slow rate of progress or a lack of progress altogether. If there were very little increase in productivity, or none, then the whole economic progress of the country, given the size of the effective working population as already largely determined, would be retarded and no real expansion of our national income and of the real income of the people could take place.

The available information on the subject is unfortunately in inverse ratio to its vast importance. The information covers too short a period and is less detailed and less accurate than would be required for thorough appraisal. But the broad trends of progress can nevertheless be indicated, and compared with trends in the United States.

I. CHANGES IN INDUSTRY AS A WHOLE

In manufacturing and kindred industries (i.e. manufacturing, mining, building and public utilities) in the thirty-year period of 1907 to 1937, the estimated increase in output per wage-earner amounted to 47% and the increase in output per man-hour to 65% (see Table 13 (*b*)). In the same period the increase in the U.S. amounted to 71% in output per wage-earner and to 133% in output per man-hour. In both respects the rate of increase was higher, in terms of man-hours nearly twice as high, in the U.S. than in Britain. Over the thirty years observed the average compound rate of increase amounted to 1·4% per wage-earner per annum and 1·7% per man-hour per annum in Britain, and to 1·8% per wage-earner per annum and 2·9% per man-hour per annum in the U.S.

Table 11. *Average compound percentage rate of annual increase in productivity in U.K. and U.S. industry*, 1907–37

	Output per wage-earner U.K.		U.S.		Output per man-hour U.K.		U.S.	
	1907=100	1924=100	1907=100	1924=100	1907=100	1924=100	1907=100	1924=100
1907-37	1·4	—	1·8	—	1·7	—	2·9	—
1907-24	0·5	—	1·8	—	1·4	—	2.8	—
1924-37	2·4	2·4	1.8	1.7	2·1	2·3*	3·0	3·0

* Annual % increase over period 1924–35

This rate of progress is obviously unsatisfactory and is due to the fact that British progress was retarded during the first world war, while in the U.S , although there was little progress in the 1914–19 period, a very rapid increase started in 1919 and from then the progress was continuous In the 1907–24 period, for example, the annual compound rate of progress in Britain was 0 5% per annum per wage-earner and 1 4% per annum per man-hour, while in the U S. in the same period it was 1 8% per annum per wage-earner and 2 8% per annum per man-hour.

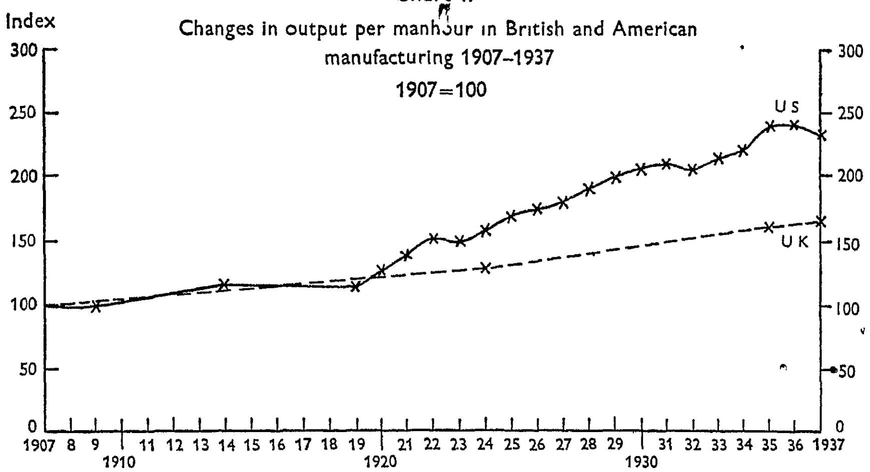
In anticipating future trends it is more relevant, therefore, to consider changes in productivity in the inter-war period of 1924–37.* In these 13 years output per wage-earner in manufacturing increased by 37% (i e at the average compound rate of 2 4% per annum) No good measurements of output per man-hour are available, but there were no fundamental changes in working hours in Britain in this period With increasing business activity actual hours of work slightly increased, and changes in output per man-hour appear to be throughout this period below the level of output per wage-earner. In the comparable period (1924–37) the position in the U S was very different from that in Britain The absolute increase in output per wage-earner amounted to only 25%, and the average compound rate of increase to 1 8 per annum, both of which were lower than in Britain At the same time, however, the United States succeeded in decreasing working hours and made up for the greater leisure of the worker by higher output per man-hour, so that output per man-hour in the period increased by more than output per wage-earner (by 47% in the 1924–37 period, corresponding to an average compound rate of 3% increase per annum). Thus American development was in this period again more favourable than British development. Chart 2, p. 44, shows the changes in output per worker and in output per man-hour in the two countries over the 1907–37 and 1924–37 period As can be seen, in addition to a higher rate of increase, there has also been a fairly high degree of constancy in the increase in the U.S , which was absent in the U K. A more continuous increase is shown in output per man-hour for the U K. in the 1907–37 period, but the curve is based on too few points to be of great value. In the 1924–37 period output per man-hour showed a greater increase in the U S than in the U K ; it also showed a continuous increase (whereas output per worker fluctuated) In this period the U K. development was also fairly continuous and appeared to gather momentum as it proceeded.

There is little information available on changes of productivity during the war, and in the reconversion period In the U.S , as the Bureau of Labor Statistics indices indicate, there was a further increase in productivity between 1937 and 1939 From then onwards changes in productivity could only be measured in industries where the product structure remained fairly unchanged. In industries which switched to munitions production, the change of product was too great to allow productivity comparisons with pre-war conditions. There were, of course, a number of other changes, e g affecting the composition of the labour force (such as employment of a larger number

Chart II

Changes in output per manhour in British and American manufacturing 1907–1937

1907=100



of women and older people). The Bureau of Labor Statistics compiled productivity indices for over two dozen civilian industries (including cotton, wool, leather, boots and shoes, etc) The increase in these industries in output per worker during the 1939–45 period can be put at 7% It is well known that in the munitions industries proper, productivity has increased substantially, owing to the application of mass-production methods to large orders for standardized items, as well as owing to the introduction of new techniques. The over-all increase in productivity (in terms of output per man-hour) has been put at 25 per cent for the 1939–44 period by the War Production Board Owing to many inherent difficulties of measurement, this figure is of course speculative, and in any case it has to be seen how far the gains in productivity in munitions production will prove advantageous in the production of peace-time manufactures.*

The position in the U K. is perhaps not fundamentally different from that in the U.S There are known to have been increases in productivity in the production of munitions once the orders were big enough and mass-production methods could be applied, and there were probably few changes in productivity, on the average, in civilian consumption industries. There were, however, some differences In the British munitions industry there was probably less new investment than in the American. In civilian consumption goods industries, differences were more profound. Most of the factories worked well below full capacity with a different labour force and inferior raw materials, producing different articles as compared with pre-war conditions. Most war-time factors which affect productivity unfavourably—black-out, air raids, dispersal for strategic reasons, changes in the type of production, changes in labour composition, dilution of labour, etc.—were not operating or were operating to a smaller extent in the U S than they did in Britain. At the same time some war-time changes such as rationalization of

* In 1946 productivity levels were affected by reconversion difficulties in the United States Nevertheless, by 1947 productivity was thought to be back at pre-war level and rising, although at a lower rate than was experienced after the last war.

production methods, use of special purpose machinery, standardization of products and of design (in connection with utility production and in general) and similar factors may have affected British output per worker favourably during the war All these factors make it difficult to judge how productivity has been affected by war-time conditions and even more difficult to see their effect on post-war trends For the latter, the known decrease in productivity in such basic British industries as coal-mining, cotton and wool is serious, while increases may have occurred in such industries as boots and shoes, hosiery, chocolate confectionery, etc In the last two cases increase in productivity was largely due to a switch-over to more standardized qualities and to discontinuing the more elaborate products and cutting down in variety.*

All available evidence suggests that overall productivity in manufacturing has probably changed little since before the war (1935), the movements of output and employment data do not indicate any sign of big decreases since that time, and they show small improvements (albeit with interruptions) over the post-war years. Neither the United States nor, much less, Britain has made up for the losses in the normal annual rate of increase of productivity between the pre-war period and the present But the exact position will be known only when results of the first full post-war production censuses† become available.

2. CHANGES IN PRODUCTIVITY OF LABOUR IN THE MAIN INDUSTRY GROUPS

There was an increase in productivity of labour in nearly all the main industry groups during the 1907–35 period, the longest period for which information is available Owing to the average decrease of working hours from 53 8 to 47·8 output per man-hour increased throughout by more than output per worker (See Table 14)

Taking productivity of labour in 1935=100‡ the largest increases since 1907 can be observed in the paper, printing, and publishing group (52 points per worker and 56 points per man-hour), public utilities (48 points per worker), iron and steel and engineering (36 points per worker and 42 points per man-hour), chemicals (36 and 42 points), clay, building materials and building (30 and 38 points) In all the above cases the absolute, as well as the annual, increase has been above (or, in the last case, at the level of) the average increase in industry, 30 points per worker and 38 points per man-hour In the following main groups the increase has been below the average for industry

* For U S , see C S Gody and A D Searle, 'Productivity Changes since 1939', *Monthly Labor Review*, December 1946, also War Production Board, *American Industry in War and Transition*, 1940–50, Part II, July 1945

For U K , see *Monthly Digest of Statistics* for coal, *Working Party Reports* on *Cotton, Hosiery, Wool, Industrial Record*, 1919-39, issued by Cadbury Bros Ltd , 1945, pp 38-9, for chocolate confectionery

† These are held in respect of the year 1947 in the U S , and in respect of the year 1948 in the U K

‡ 1935 has been chosen as the only year which can be used as a base year for both countries. It should be noted that while changes for the industry as a whole are given in percentages, for the main industry groups and individual industries they are given in points relating to the 1935 index Percentages can be easily calculated from the tables

as a whole. textile and clothing (25 and 36 points), leather (22 and 31 points), timber (19 and 27 points), miscellaneous (17 and 25 points), non-ferrous metals (11 and 18 points), mines (5 points per worker), and food, drink, tobacco (—1 point per worker and +10 points per man-hour). In the last three groups, namely miscellaneous, non-ferrous metals, and food, drink and tobacco, the rate of increase in output per man-hour has been below 1% per annum

Trends of productivity in the main industry groups in Britain and the U S. cannot be compared satisfactorily, for statistical reasons * On the basis of what information is available, the following picture emerges comparing development in output per worker in the 1907–35 period in the U.K. with development in the 1909–35 period in the U S , the rate of increase was much greater in the U S vehicles and tobacco industries, which are parts of main industry groups in Britain; it was also greater in the U.S. chemicals, textile and clothing, and food and drink industries, and in mining. The rate of increase was approximately the same in the paper and printing industry of the two countries, but it was lower in the U S iron and steel, leather, timber, clay and building materials and in the non-ferrous metals industries; in the latter there was in fact an absolute decline in the U S. There are, however, two further factors in favour of development in the U S Firstly, the taking of 1935 as the end year of comparison may be justified on the purely statistical ground of choosing a year which is identical with that of British series, but it distorts the real picture. In all the main groups observed (except vehicles) there was a further increase in U S. output per worker in the 1935-9 period, and taking the 1909-39 period as our basis of comparison the U S progress has been greater in all industries except leather Secondly, for lack of man-hour data for the main groups of industries, no direct comparison can be made of changes in output per man-hour in the two countries, but, as available information relating to man-hours in individual industries suggests, there is no single main industry group in which the rate of increase in output per man-hour was smaller in the U S than in Britain.

3. CHANGES IN PRODUCTIVITY OF LABOUR IN INDIVIDUAL INDUSTRIES

For some of the individual industries for which productivity of labour in the U K and U S has been compared, the rate of increase in productivity has been also analysed British information is available for the three years 1924, 1930 and 1935 only, and even this material has serious statistical defects and consequently a high margin of error,† it can be compared with the U S material relating to the period 1924–35

Taking output per worker or per man-hour in 1935 as equal to 100, the average increase in British manufacturing industry can be put at 25 points per worker and 21 per man-hour

The following changes can be observed in 26 selected industries.

* The classification is somewhat different, and the years of census are different As the rate of increase in productivity is by no means a continuous process, the choice of years of comparison, i e the state of business activity in the years compared is obviously of importance

† See Bibliographical and Statistical Note on p 249

Table 12 *Approximate changes in output per worker and per man-hour in 26 U K and U S industries, 1924-35*

	Approximate changes in output per worker between 1924-35 in points (1935=100)		Approximate changes in output per man-hour between 1924-35 in points (1935=100)	
	U K	U S	U K	U S
Above British average				
Cement	+62	− 9	+61	+30
Rubber	+57	+28†	+55	+46†
Motor and cycle	+39	+27	+37	+49
Sugar, glucose	+37	+24†	+32	+42†
Paper	+37	+14	+31	+26
• Sugar confectionery	+37	+26‡	+30	+46‡
Soap	+35	+29†	+32	n a
Pig iron	+34	+28	+31	n a
Linoleum and oilcloth	+31	n a.	+27	n a
Linen	+30	− 4	+29	n a
Matches	+29	n a	+33	n a
Tobacco	+27	+20	+21	+42
Glass	+25	+23	+21	+45
Average	+25	+17	+21	+34
Below British average				
Boots and shoes	+23	+20	+22	+34
Steel rolling	+21	+ 2*	+17	+32*
Woollen and worsted	+20	+14	+19	+31
Biscuits	+18	+21	+16	n a
Hosiery	+18	+20†	+11	+40†
Cotton textile	+17	+ 3	+12	+33
Ice	+16	+24†	+12	n a
Foundries	+15	n a	+15	n a
Grain milling	+15	Nil	+15	+21
Brick	+14	−23	+11	+10
Tinplate	+ 5	n a	+13	n a
Brewing and malting	− 2	n a	− 5	n a
Fish curing	− 3	n a	−11	n a

n a.=not available

* Including blast-furnaces † 1923–35 ‡ 1925–35.

Sources The U K data, which are very approximate, are based on *Census of Production* data indices of the volume of output, as derived from census reports, were related to movements of employment as shown in the *Census* In estimating changes in output per man-hour, allowance has been made for changes in actual yours of work, as shown by the *Earnings and Hours Inquiries* of the Ministry of Labour (See Bibliographical and Statistical Note, p 249)

The U S data are based on productivity indices of the Bureau of Labor Statistics and on S Fabricant, *Employment in Manufacturing*, 1899–1939, New York, National Bureau of Economic Research, 1942

It can be seen that of the 26 industries included in this review the greatest increases in productivity in Britain have been experienced by the cement industry, and after that in the new industries such as rubber, motor-cars and sugar and glucose, the last-named being virtually a new industry in Britain. There has been less progress (below the average) in our traditional basic industries such as cotton, woollen and worsted, hosiery, steel smelting and rolling (with the exception of blast furnaces), foundries The smallest increase has been experienced in the grain milling, brick and tinplate industries, while in brewing and fish curing there was a decrease These latter results do not contradict what we know about these industries.

Even these groups are too wide and a closer examination would find that decreases or small increases in some sub-groups counterbalance greater increases in other sub-groups within the same industry. For example, even in cases of such homogeneous industries as bricks it is known that development was more pronounced in one important sector, the Fletton sector, while the

Table 13. *Estimated long-term changes in production, employment, and productivity in U.K and U S industry*

(*a*) *Changes in production, employment, and productivity in the inter-war period*

Year	Volume of Production	Employment	Output per head	Output per man-hour
	United Kingdom (manufacturing)			
1924	100	100	100	100
1925	—	—	—	—
1926	—	—	—	—
1927	109	100	109	—
1928	108	99	108	—
1929	115	101	114	—
1930	106	94	112	—
1931	95	86	110	—
1932	95	85	111	—
1933	104	88	117	—
1934	117	93	126	—
1935	126	94	133	127
1936	137	100	137	—
1937	145	106	137	—
1938	130	103	126	125
	United States (manufacturing)			
1924	100	100	100	100
1925	112	103	108	106
1926	119	105	112	110
1927	119	103	116	113
1928	125	103	121	120
1929	137	110	125	126
1930	117	95	123	129
1931	98	81	123	132
1932	74	69	108	129
1933	86	76	112	136
1934	95	89	107	139
1935	113	94	121	151
1936	133	102	131	151
1937	141	112	125	147
1938	111	94	119	151
1939	141	104	136	166

Notes (*a*) Mining is not included in the U S series Its inclusion, however, would not alter the trend substantially, as the changes in labour productivity run broadly on parallel lines See S Fabricant, *Labor Savings in American Industry*, 1899-1939, 1945

(*b*) The sharp decline in output as compared with the small decline of employment between 1937 and 1938 is explained by the fact that the index covers armaments deficiently See R and W M Stone, 'Indices of Industrial Output', *The Economic Journal*, Vol XLIX, 1939, p 485

Sources U K Production *London and Cambridge Economic Service*, Annual Index It excludes building and contracting This series follows very closely the indices based on census results for census years Employment indices, constructed by R Stone on the basis of insurance statistics, allowing for unemployment Both series quoted from Stone, op cit Output per man-hour series based on actual hours worked in the trades covered except mining, as ascertained by the *Earnings and Hours Inquiries* of the Ministry of Labour The actual data were 1924, 45 7; 1935, 47 8, 1938, 46 2 (for all industries covered, 46 5) The 1938 data

global figure was modified by the smaller development in the other sectors.

When comparing trends of productivity in individual industries in the U.K. and the U.S. it should be borne in mind that data relating to the years 1924–35 are less representative of the U.S. development in the inter-war period than is the case with Britain. In almost all cases there have been substantial further increases in the United States in the 1935–9 period. Secondly, only output per man-hour comparisons between the two countries are relevant since, as has been shown above, in the inter-war period the main factor in American development was a reduction in working hours and a sustained (or increased) production in spite of this reduction.

Table 13—*continued*

(*b*) *Long-term changes in production, employment and productivity in manufacturing and kindred industries*, 1907-37*

Year	United Kingdom (manufacturing, mining, building, and public utilities)			
	Volume of production	Employment (wage-earners)	Output per wage-earner	Output per man-hour
	(1)	(2)	(3)	(4)
1907	100	100	100	100
1924	124	115	108	127
1930	133	110	121	n a
1935	159	111	143	161
(1937)	(184)	(124)	(147)	(165)
	United States (all manufacturing industries combined)			
1907	100	100	100	100
1924	165	121	136	158
1930	193	116	167	205
1935	187	114	164	240
1937	234	136	171	233
1939	232	126	185	263

n a = not available

* It should be noted that the coverage of the two sets of statistics is not identical, as the British figures include building, mining, and public utilities. No information is available on changes in output or productivity in building (in the 1907–24 period). Of the two other industries there was a declining trend of both production and productivity in mining and an increasing trend in public utilities. Thus the picture given above would not be altered substantially by the exclusion of these two industries.

Sources U.K. The 1907–24 comparison of output, employment, and output per wage-earner are based on N. A. Tolles and P. H. Douglas, 'A Measurement of British Industrial Production', *The Journal of Political Economy*, February 1930.

Volume of production data for 1924–35 were taken from E. Devons, 'Production Trends in the United Kingdom', *The Manchester School*, Volume X, 1939.

Employment data for 1924–35 are based on the Final Summary Tables of the 1935 *Census*.

Actual man-hours worked per week for 1906, 1924, and 1935 were taken from the official *Earnings and Hours Inquiries*. The following are the actual data: 1906, 53.8, 1924, 45.7, 1935, 47.8. It should be noted that these enquiries did not cover mining.

The 1937 data are given in brackets, as they are not strictly comparable with data relating to previous years. It has been assumed that there was no change in working hours in 1937, as compared with 1935.

U.S. S. Fabricant *Employment in Manufacturing*, p. 331.

U.S. man-hour data were: 1907, 57.3 (full-time hours), Actual hours: 1909, 52.7, 1924, 45.4, 1930, 43.5, 1935, 36.5, 1937, 38.6, 1939, 37.6. See Fabricant, op. cit. p. 234.

See the Bibliographical and Statistical Note to this chapter on page 249

CHAPTER V

FACTORS AFFECTING PRODUCTIVITY DIFFERENCES

I. SPECIAL FACTORS AFFECTING INDIVIDUAL INDUSTRIES

There is no single factor which will explain the differences in productivity in different countries. In an ultimate analysis only a detailed study of the individual industries concerned would reveal all the specific factors, physical, economic, institutional, etc , which account for such differences

(i) Some of the factors influencing output per worker are, of course, always specific factors operating in particular industries of individual countries. The operation of these factors is usually beyond the control of the industry concerned, though this is in some cases truer than in others. Physical, geographical and geological factors are foremost among these factors • A few examples can be mentioned. It is generally known that the high output per man-shift in U S. coal mines is due to their favourable natural conditions, which finds no parallel elsewhere * The same applies to iron-ore mining in the U.S. Or to take another case, the British pig-iron industry to some extent needs more labour per unit because the iron content of the iron ore used is low, and therefore more ore and coal has to be handled per unit of pig iron than is needed in the U S In these examples natural conditions have not favoured the U K , but in a case such as the Fletton sector of the British brick industry natural conditions are in favour of low labour requirements per unit of output Locational advantages influencing labour requirements would also fall into this category

(ii) The specific conditions can also be connected with institutional factors. Most types of output restrictions, whether by cartels or trade unions, would fall into this category. A further important institutional factor may be the prevailing system of taxation In the British tobacco industry the fact that a high rate of duty is collected in Britain before manufacture, i e. before the entry of the tobacco leaf into the factory, leads to a considerable expenditure of labour to prevent wastage In the United States and in Germany revenue is collected on the manufactured product at the point of sale to the distributor The British system of motor taxation until 1947 has had a profound effect on engine design and indirectly on standardization An institutional factor of a quite different type is the supply of machinery in the boot and shoe industry by the leasing system † which enables manufacturers of all sizes to be equipped with modern machinery. ‡

(iii) Among the specific economic factors the most important one is the type of the market. Some industries, or sectors of industries, in individual countries may not aim deliberately at a high output per head, but rather at a

* See *Coal Mining Report of the Technical Advisory Committee* (Reid Report), H M Stationery Office, 1945, para 137 and ff.

† See *Working Party Report on Boots and Shoes*, London, H M Stationery Office, 1946, pp 15 ff

‡ The same system operates, of course, in the U.S , but it is mentioned here as an example of potential institutional differences affecting output per worker

high value per unit by using expensive raw materials as well as putting in much labour per unit of output Sectors of the individual industries in each country will be specialist producers in this sense, producing high-quality goods to satisfy the special requirements of the market But in some countries whole industries may have become—rightly or wrongly—specialists, in any case the proportion of mass-produced to specialist production in each individual industry of different countries will vary

When appraising the significance of productivity differences it is essential to bear in mind the effect of these specific factors on output per head. It would be a great mistake to underestimate the significance of these factors—especially in so far as they are beyond the control of individual industries But it would be equally wrong to overestimate their significance After allowance has been made for these factors, differences in relative productivity would perhaps become smaller, but they would still exist in practically all the industries that have been analysed We turn therefore to an examination of those general factors which may affect output per head in all the industries While a very impressive list of these general factors can be easily catalogued, a small proportion of them only can be analysed in quantitative terms.

2. GENERAL FACTORS: DIFFERENCES IN THE DEGREE OF CAPITAL INTENSITY

(1) By far the most immediate factor affecting output per worker is the amount of machinery available It is a generalization of common sense that the worker helped by machines will produce more than the worker operating with little or no machinery The question of whether there is any direct relationship between the amount of machinery available per worker and the quantity of output per worker requires, however, careful analysis But even if one could prove the existence of such a relationship, this would not mean that output per worker could be automatically increased by adding to the available equipment per worker employed A number of other factors are closely interconnected with the amount of machinery employed and it is very difficult indeed to disentangle the effect of these several factors

It is obvious that the amount of machinery available will depend on the size of the plant (and firm) A small plant, or a small firm, is neither in the financial position, nor has it the necessary turnover, to install costly machinery The size of the plant, on the other hand, is determined by the size and the character of the market, as well as by many other factors. It is equally certain that the installation of machinery in itself will not procure high output per worker, unless the production is sufficiently standardized to allow the economical use of this machinery All these considerations should make us cautious in evaluating the effect of mechanical changes on productivity

One further point has to be remembered We have seen already that more machinery per worker employed does not necessarily mean the use of more indirect labour per unit of output This will depend on the relative amount of output per worker in the particular industry as well as on the productivity of the machine-making industries

Lastly, from the theoretical point of view it is not sufficient (and some

would say it is not even relevant) to consider capital equipment available per worker, we have also to consider capital equipment per unit of output. Ultimately we are interested in the amount of real resources used per unit of output In so far as direct labour is replaced by capital, we have to relate capital to output (and not to labour), as this will indicate the degree of substitution of one factor of production for the other, as well as the total amount of real resources used per unit of output. For this reason we will also consider the amount of capital equipment per unit of output.

(*a*) Measuring capital equipment available per worker by horse-power per worker the following general picture emerges

	Horse-power per worker
United Kingdom, 1930*	
Factory Trades	2 83
All manufacturing trades	2 51
United States, 1929†	
Factory Trades	4 91
United States, 1939†	
Factory Trades	6 42
Germany, 1933‡	
All manufacturing trades	3 76
Switzerland, 1937§	2 70
Switzerland, 1944§	3·40
Holland, 1937‖	3 80

* Horse-power available (horse-power of prime movers plus that of electric motors driven by purchased electricity)

† Total power installations as under *

‡ Based on *Gewerbezaehlung* of 1933, excludes small firms with less than 10 employees. It covers prime movers plus electric motors, but it is uncertain as to whether it excludes electric motors driven by electricity generated in own works See *Statistisches Jahrbuch*, Part V, *Gewerbe* Public utilities are excluded

§ It is not stated how total horse-power was arrived at, based on data in the *Annual Statistical Yearbook*

‖ Primary capacity figure relates to a sample of industry thought to be probably representative for industry as a whole Estimate of the Dutch Central Bureau of Statistics

More details relating to the U K and U.S are given in Table 15, where changes in time in horse-power per worker are shown for the last generation

In so far as the inter-country comparisons are concerned, it can be seen that the ratio of horse-power per worker in the U K and U S. bears the same relation as the ratio of output per worker in the U K and U.S ,* i.e , broadly speaking, output per worker is double in the U S and horse-power per worker is also double. Also the higher rate of increase in horse-power per worker in the U.S. runs parallel with the higher rate of increase in output per worker in the U.S. The average increase in horse-power per worker per annum amounted to 0 075 h.p in the 1924–30 period in the U K. and to 0·150 h p. per annum in the 1925–39 period in the U.S. Simultaneously the productivity (output per man-hour) increases were at the compound rate of 2 3 in the U K. and at the compound rate of 3·3 in the U S during the 1924–35 and 1924–37 periods respectively.

On the other hand, Germany and Holland appear to have more horse-power per worker than Britain, though their output per head is approximately on

* This is the case especially if we estimate the U K horse-power per worker data for 1935 on the assumption of a constant rate of annual increase.

the same level A number of less-developed countries (especially in south-east Europe), possessing a small but new industry, have a relatively high amount of horse-power per worker (sometimes higher than in Britain) though their output per head is known to be well below British levels * No great importance should therefore be attached to the fact that in the U K /U S comparison the ratio of productivity corresponds to the ratio of horse-power per worker We shall find great differences when we analyse (*b*) the distribution of available horse-power in the U.K. and U S. in different industries, and (*c*) the relative amount of horse-power per worker in the individual industries of the two countries

(*b*) Although the distribution of workers is not very different in the U K and U.S , the distribution of horse-power differs substantially (see Table 16) In both countries over two-fifths of all horse-power is concentrated in the metal and engineering industries, but the proportions for other industries differ. In 1930 still well over one-quarter of all horse-power was concentrated in the textile and clothing industries in Britain, while in the U.S it was 9 9 and 7 8% in 1929 and in 1939 respectively On the other hand, much more horse-power is concentrated in the U S. chemical industries (including petroleum refining)—9·7 (1929) and 12·2 (1939), as against 6 4 (1930) in the U K There is also more horse-power in the U S. food, drink and tobacco industries, 11 0 (1929) and 11 5 (1939), as against 6 4 (1930) in the U K , and in the timber industries 7 2 (1929) and 8 8% (1939), as against 2 5% in the U K

(*c*) These differences in the distribution of total horse-power, which are partly explained by differences in industrial structure, already suggest differences in the ratio of horse-power per head and in the ratio of output per head in individual industries These indices have been tabulated for all industries for which such information is available, in Table 17 Altogether 28 industries are included. This comparison does not suggest any close correlation between the relative amount of horse-power per worker and relative productivity There are, broadly speaking, three categories

(1) Out of 28 industries for which both indices have been worked out,† in the following six cases there appears to be a close inter-relationship between the two, in the sense that *x* times horse-power per worker is associated with *x* times output per worker·‡ smelting and rolling of iron and steel, woollen and worsted, linoleum, paper, rubber tyres, boots and shoes

(2) In the following 14 industries the U.S employs disproportionately more horse-power per worker to achieve a higher output per worker foundries,

* See Colin Clark, *Conditions of Economic Progress*, London, 1940

† The classification which follows made a rough allowance for potential changes in horse-power per worker in Britain since 1930 The classification is thus rather a matter of judgment based on all relevant factors than a precise correlation

‡ Strictly speaking, output per man-hour data should be taken for such comparisons, these are even less favourable to the U K On the other hand, multiple shift working has not been considered when calculating the U.S. horse-power per worker figures.

cement, bricks, coke, seed crushing, rayon, motor cars, hosiery, tobacco, breweries, matches, beet sugar, grain milling, and fish curing It should be noted that in some of these industries (notably cement, rayon, motor cars and beet sugar) heavy investments have taken place in the U.K since 1930 which would affect the above findings. in the case of bricks the low use of U S capacity is worth noting.

(3) In the following eight cases, U.S. advance in productivity is higher than the relative amount of horse-power per worker· machinery, cotton textile, tin cans, glass containers, wireless sets, biscuits, and bread, soap and ice

In six cases only, out of 28, there exists therefore a proportionate relationship between productivity and horse-power per worker. In most cases the U.S. achieves a higher output per worker by a more than proportionate employment of horsepower per worker It is probable that on the basis of more recent and exact information some of these industries would fall into the first group It is also interesting to observe that in eight industries out of 28 high output per worker is not associated with equally high horse-power per worker.

Table 17 also gives information on horse-power in use per unit of output, and this comparison is of great interest In 14 industries out of 28 either approximately the same amount of horse-power is used per unit of output as in Britain (the first group above) or less is used than in Britain (the third group above). In 14 trades only is there prima facie evidence that the U.S. is using more horse-power per unit of output than Britain. In some of these industries this may be due to low use of capacity, so that horse-power per unit of potential output may be closer in the two countries. Nevertheless the fact that in nearly half of the industries analysed horse-power per unit of output is higher in the U S. than in the U.K is of substantial interest. It does not explain, however, the higher U S productivity, as there is no correlation between horse-power per unit of output and output per worker, i e. industries where horse-power per unit of output is higher in the U.S are not identical with industries where U S. output per worker is also relatively high. For example, in cement output per worker is perhaps higher in the U.K , but horse-power per unit of output is much higher in the U.S.; in the production of tin cans or glass containers, U S. output per worker is much higher, though horse-power per unit of output is lower

(ii) Horse-power per worker is, at best, an indicator of the quantity of machinery available, and this is not the only characteristic of capital equipment in which we are interested The quality, size (type, efficiency, etc) of the machinery as well as the application of modern technique in general, is of equal importance, even though it cannot be approached by a general quantitative survey but only by an industry-to-industry analysis

(*a*) The general trend of manufacturing technique was by no means entirely in the direction of increasing the amount, and even less in increasing the horse-power, of the machinery. Machines of modern designs or new processes did not mean necessarily either more machines or more horse-power per

worker * Statistics frequently do not indicate that an industry may fall behind its opposite number in other countries not only in the amount of machinery employed† but also by not introducing new types of processes and new types of machines. Automatic looms, ring spindles, modern winding machinery, continuous-strip mills, tunnel kilns, and a host of other automatic machinery are the most obvious examples.

In so far as the quality of the machinery in the U.K and U.S. is concerned, the census data give little information In both countries the horse-power statistics distinguish between the types of machinery according to driving power. In so far as prime movers are concerned, steam engines are decreasing in importance and are being replaced by steam turbines This process can be observed in both countries, but has gone further in the U.S. than in the U.K A more important development is the increasing application of power electrically instead of mechanically (i e directly from prime movers). This development—another indirect index of technical progress—has again gone much further in the U S than in the U.K , as can be seen from the following figures

		Power applied mechanically	Power applied electrically
* U K	1924	46 8	53·2
	1930	33 8	66 2
† U S	1925	29 0	71 0
	1929	21 0	79 0
	1939	15 0	85 0

* For U K power in use in factory trades

† For U S power available No allowance has been made for loss of power in transmission from generators to electric motors in own works

(*b*) Another factor which would throw some light on the quality of machinery used would be data on the age of available equipment. This is again a subject on which very little reliable information is available in Britain. A detailed investigation was undertaken in the cotton-spinning industry in October 1946‡ which showed that, with few exceptions (speed frames, combers), virtually all equipment had been purchased before 1935, although

* An American study on the effect of technological changes on U.S industry calls attention to the following types of technical changes Most changes affected the type of machines used. These changes were sometimes mechanical, e g the continuous-strip mill Sometimes the changes were non-mechanical, e g the replacement of welding for riveting Some changes led to the improvement of single-function machinery by eliminating one or more hand operations In some cases it led to an increase in speed, as in textiles, in others it meant the enlargement of capacity, as in cement, for pig iron and steel it meant bigger furnaces.

But technical changes also occurred in connection with the materials used Old products have been replaced by new substitutes, saving labour, e g painting of motor cars by natural enamels has been replaced by synthetic enamels which dry quickly The durability of some products has been increased, thus requiring less labour in repair and maintenance (e g cable and wire)

See *Technology in our Economy*, T N E C Monograph, No. 22

† A detailed analysis, industry by industry, would no doubt also call attention to existing differences in the use of machinery in the main processes and the application of machinery in auxiliary processes The U S is far more heavily mechanized in the auxiliary processes than Britain, this obviously was conditioned by the relative price of capital and labour The fact that Britain has been behind the U S. in this respect is more understandable, though hardly of lesser importance

a large part was reconditioned recently Several of the Working Party reports, especially those on woollen and worsted,* lace,† and light clothing,‡ indicate that a substantial proportion of the equipment of these industries is old Old machinery, especially if properly reconditioned, is not necessarily inefficient machinery, and although reluctance to apply new machinery is retarding increases in productivity, it would be exaggerated to regard the use of old machinery as a sign of general technological stagnation § It is difficult to judge how far the old age of the machinery in the several British industries is responsible for productivity differences, especially if we consider that the general belief which is widespread in Britain—that capital equipment is completely up to date in the U.S A and that there is a very rapid rate of renewal of machinery—is not borne out by the facts. It may be true in individual industries; it does not appear to be true for industry as a whole. According to a study made by Mr G. Terborgh** in 1940, 'the gap between the average quality and condition of durable goods in use and the best that current technology affords is . . much wider than before the depression' The last decade (1930–40) before the war, he asserts, was a period of stagnation in the renewal and expansion of the inventory In 1925 only 44% of machine tools in use were more than ten years old, in 1930 this percentage had risen to 48%; in 1935 it was 65% and by 1940 the proportion had risen to 70%. Of the locomotives, there were 80% over ten years of age in 1930, 94% in 1940, of railroad freight cars 66% and 86% respectively; of electric generating capacity 35% and 75%

There have been, of course, vast changes during the war, but it is by no means the case that all American industry is operating the most recent and newest capital equipment

(*c*) Another aspect of the same problem is the rate of replacement of capital equipment It would be interesting to know whether the rate of replacement of capital equipment is quicker in the U S. than in the U K , and also whether the man-power used year by year for this purpose (producing capital equipment for replacement as well as new equipment) is proportionately greater in the U.S. than in the U K If it were true that higher U S output per head of products entering into final consumption is achieved only by an unduly high proportion of U S labour being employed in producing capital goods, higher U.S. productivity would not mean higher real incomes and higher standards of living Three factors will determine the size of the labour force needed to produce the capital goods both for replacement and for addition to the existing capital equipment: the amount of machinery used, the rate of replacement, and the productivity of labour in the machinery and constructional industries

A rough statistical estimate has been made for industry as a whole by con-

* *Working Party Report on Wool*, H M Stationery Office, 1947, p 76

† *Working Party Report on Lace*, H M. Stationery Office, 1947, p 38

‡ *Working Party Report on Light Clothing*, H M Stationery Office, 1947, pp 28, 29, 38

§ See the pamphlet of the Machinery and Allied Products Institute, Chicago, on *Technological Stagnation in Great Britain*, January 1948

** *Federal Reserve Bulletin*, October 1940 Mr. Terborgh is also part-author of the pamphlet quoted in footnote §

jecturing the number of workers employed producing machinery and equipment in industry as a proportion of total man-power in industry For the U K (1935) the following estimates can be conjectured

Persons employed in engineering, producing machinery for manufacturing and mining (i e not taking into account those producing agricultural machinery, marine engineering, laundry, road-making machinery, etc), allowing for exports and imports	about 400,000
Persons employed in building construction for manufacturing and mining*	„ 70,000
Persons employed producing vehicles for industry	„ 30,000

* Bowen and Ellis put the gross value of building of factories in 1935 at £26 millions out of a total value of £494 millions for building and construction, and the persons employed at 964,000 If allowance is made for repairs, etc , the above estimate is not inconsistent with these figures See Ian Bowen and A W T Ellis, The Building and Contracting Industry', *Oxford Economic Papers*, No. 7, March 1945.

The total is approximately 500,000 out of a total employment of about 6½ million persons, including those employed in small firms, i.e. 7 7%.

A similar estimate for the U S. (1937) would give the following figures.

Persons employed in producing machines		500,000
construction		200,000
producing vehicles		50,000–100,000
	Total	750,000–800,000

out of a total 12 million, i.e. 6 25–6 66%.

Another type of estimate gives lower figures for the U S This second approach is presented in the Federal Reserve Board calculations (by Mr. Terborgh) into estimated expenditures for new durable goods in the period 1919–38 * He puts the total amount spent on durable goods in manufacturing and mining in 1937, which was a peak year, at

	$ (millions)
Plant	1,053
Equipment	2,069
Total	3,122

—these figures already including transport costs and distributive margins. These data can be converted into man-power data on the basis of the known gross output value per head They would give 260,000 persons employed in producing plants and 320,000 persons employed in producing machinery

However rough and conjectural these estimates may be, they do not suggest that a higher proportion of the labour force of the U S is employed in making capital goods in fact the proportion is probably very nearly equal in the two countries, though perhaps somewhat lower in the U S † Considering the higher output per worker in the U S machine-making industry this also

* His estimates cover plant and equipment charged to capital account, and thus exclude accessories, small tools, parts, as well as repair and maintenance He uses *Census of Manufactures* figures, then allows for distributive margins and transport costs He also allows for exports and imports, and then raises his estimates for potential 'undertabulation' (i e disregarding products of some trades other than engineering which might count as equipment) Lastly, he allows for equipment produced in the establishment with bought parts and accessories The increase on these two last accounts is 25% in his estimates

† It is not possible to make allowances for the potentially different rates of *new* investments, but this may not alter the picture

means that either the addition to the capital stock or the rate of replacement, or both, are quicker in the U.S. than in Britain.*

3. GENERAL FACTORS: FACTORS BEARING ON CAPITAL INTENSITY

(1) The size of the market (as measured by the volume of output of the industry) has an important influence on factors affecting output per worker. Specialization within the industry, in the sense that parts, accessories, semi-finished products, etc., are produced by specialist firms or by specialized methods within the same firm, will be dependent on the size of the output which the industry can satisfactorily sell on the market. It is obvious that the degree of mechanization will also be dependent on the size of the market (output), as certain processes or part of processes will be performed by specialized machinery only if the output is sufficiently high to allow the installation of such machinery. It is an argument frequently referred to† that the U.S. owes her higher efficiency to her big market, which enables specialization and the use of specialized machinery. No doubt a certain minimum volume of output is necessary to allow of the most economic way of production, but there is no evidence to suggest that the optimum is necessarily associated with the biggest possible size of output and that the actual optimum, whatever it may be in the individual industries, could not be realized within the possibilities of British industry. Motor cars are an obvious example where a minimum volume of mass-production is necessary to make for economic production (i.e. to pay for costs of dies, etc.) The volume by which economies of scale can be fully obtained is a series of 30,000 to 40,000, which is feasible within the limits of the British market.

The size of optimum production cannot be decided in general terms, but needs to be analysed industry by industry. But a broad general analysis can be attempted by relating relative output per worker in the U.K. and U.S. to the relative size of their respective industries. There are some basic shortcomings in such a comparison, namely that it has to be based on such broad groups of industries as, say, the wool industry, whereas the real comparison should be between smaller and more comparable categories, e.g. between firms producing medium-priced worsted cloth for men's wear. Secondly, we can only measure the size of the market (output), but not the type and other characteristics of the market. It is obvious that, even for identical small sectors as mentioned above, the characteristics of the market demand will be different. Thirdly, we can measure the market only by the size of output.

Bearing in mind these limitations, we find that the market for U.S. industry (as measured by the size of output) is in most cases greater in the U.S. than in the U.K. (see Table 18). It is about equal in wool and margarine, and smaller in bricks and fish curing. In such industries as iron and steel, machinery, motor cars, rubber tyres, electric bulbs, tin cans, glass containers, wireless sets, matches and ice, the U.S. market is appreciably greater than the British

* We have seen that the increase in h.p. per worker is at a higher rate in the U.S. than in Britain. But this again may mean either a higher rate of new investment or replacement of old machines by more powerful new ones.

† This thesis was very forcefully stated by Professor Allen Young, see Colin Clark, op.cit., pp. 292–4.

market There is some inter-relationship between size of the market and productivity in the sense that the greatest relative advantage in productivity in the U S is shown in industries where the U S market is relatively very big (tin cans, rubber tyres, motor cars, wireless sets, electric lamps, matches) In one case (fish curing) a smaller U S market goes with smaller productivity. But otherwise there does not appear to be a close inter-relationship In cases where the U S. market is big (e g. steel), relative productivity advantage is not above the average The same is true in such cases as ice, though this is a strongly localized industry with hosts of small plants, which may explain why the U S advance in productivity is below average There is no sign of inter-relationship between productivity and the size of market in other cases either In soap or biscuits, for example, U S productivity is relatively high, though the size of the industry is not appreciably greater than in the U K Also in a number of industries where the size of the industry is the same or smaller than in Britain (e g breweries, wool) there is an advance in productivity in the U S

While it is obvious from this comparison that in certain industries the size of the market has an influence on output per worker, this is not as great as is usually assumed. If we compare the relative productivity and the size of the market in U.K. industry in relation to Sweden and Holland (see Table 19), we can see that relative productivity is in no way related to the size of the market This points to the fact that the optimum plant (or firm) and specialization can be achieved within the limits of a smaller market (output).

(ii) It is therefore necessary to consider next the inter-relationship between the size of plant (as well as concentration of plants according to size) and productivity

The size of plant is customarily measured by the number of persons employed. In the same way, however, the size of the plant could be measured in terms of capital employed, space occupied or volume of ouput In many ways the last measurement would be the most logical from the point of view of productivity analysis, as economies of scale are related more to the scale of production and not so much to the scale of employment Also in international productivity comparisons, owing to the fact that output per worker differs, the difference between the size of plant as measured in terms of employment and in terms of output will be substantial

For statistical reasons, however, in Table 18 we measured the size of plant in terms of workers employed * As the estimated differences in output per

* The size of plant has been calculated for the well-defined census groups for which both the number of plants and the number of workers are available On the other hand output which formed the basis of the productivity comparisons has been estimated by combining results of several census trades (e g including output produced in other firms outside the industry, but excluding output of 'other' products produced in the same census trade)

In comparing the size of plant in the British and U S industries on the basis of the census, it has to be remembered that small firms with less than 10 employees have been excluded from the U K *Census* Their inclusion would invariably reduce the average size of the British plant We have not included these smaller firms, however, as we intended to have productivity comparisons and size of plant comparisons on the same basis

For reasons of both higher U S output per head and exclusion of small firms from the British data, whenever the U S plant is smaller than the U K plant in terms of employment it should be remembered that it may be otherwise by inclusion of small firms and calculating in terms of output When the U S plant is, however, on the average higher, this always means

head are known, it is easy to make adjustments and thus estimate the size of plant in terms of output

As the size of average plant (measured in terms of employment) is also affected by the exclusion or inclusion of small firms as well as by industrial classification, in addition to average size of plant we have also considered other measurements, such as concentration of employment in different-sized plants This is shown in Table 20.

(*a*) Considering first the average size of plant, we find that out of 35 cases analysed, the U S average establishment was bigger in 13 cases (much bigger in integrated steelworks, cotton textile, motor cars, tyres), the average-sized establishment was smaller in 22 cases Out of these 22 cases the average U S. establishment is probably bigger in terms of output in 12 cases, but in the remaining 9 industries (bricks, seed crushing, soap, margarine, biscuits, beet sugar, grain milling, fish curing, ice) the average U S establishment is smaller both in terms of employment and in terms of output Some of these industries are trades where the typical firm is small,* e g. bricks or ice with a widely scattered locational pattern But it is surprising to find that even in trades where there is prima facie evidence that economies can be realized with increasing scale of operations the average U S establishment is smaller than the average U.K establishment Seed crushing, soap and biscuits are the obvious examples.

There does not appear to be any definite inter-relationship between the relative size of plant and relative output per worker In two industries (motor-cars and tyres) big average size goes with relatively high productivity, but there the inter-relationship stops In other cases high relative size goes with average relative productivity and small average size with high relative productivity

(*b*) The other measurement of size of plant, concentration, indicates what proportion of employment (and thus output) is concentrated in small, medium and big firms. (See Table 20)

Comparable data† could not be worked out for all industries. This comparison indicates that:

(1) Big (bigger) plants are more important in the following U.S. industries integrated steelworks, integrated cotton, wool, motor-cars, and also to a smaller extent in hosiery, linoleum, coke and fish curing.

(2) Big (bigger) plants are more important in such U K industries as foundries, seed crushing, paper, tin cans, wireless sets, electric lamps, biscuits, grain milling, bricks The same is true to a smaller extent for pig iron, machinery, cement, boots and shoes, breweries, tobacco, beet sugar. It is interesting to note that all industries where the average size of plant is small fall into this second category.

Looking at the concentration pattern from the other angle, i e from the point of view of the importance of small firms, we find that (1) in all cases

* Typical in the sense that a high proportion of employment (say over half) is in small firms.

† Even data presented in Table 20 are not quite comparable, for reasons stated in the notes to this Table.

where big firms are more important in the U S than in the U.K , small firms are relatively unimportant (2) In some cases where big firms are more important in the U K , small firms are also more important than in the U.S , e g boots and shoes, cement In such cases in the U.K. the big and small firms dominate the scene, while in the U S medium-sized firms dominate.

This description at once suggests that there is a great variety of concentration patterns It does not appear, however, that the concentration pattern favouring big plants necessarily goes with high relative productivity, or vice versa

(iii) We have seen already that the size of market measured in terms of volume of output of the industry is in itself not satisfactory for the purposes of analysing relative productivity, it would be more satisfactory to have measurements for the size of the market for particular products But even if data for products were available, the degree of variation in the quality, size, shape, etc , of the product, in other words the degree of standardization, would have to be considered

(*a*) The importance of standardization for economic efficiency is, of course, not a new idea 'Industrial progress'—wrote Professor Robertson after the last war—'consists at the present day largely in the continuous advance towards a greater and greater measure of what is known as *standardization* Industrial operations are made as uniform as possible and reduced as far as possible to routine they are split up as completely as possible into their component parts, and each part is taken over by a separate machine This principle of standardization has been at work ever since the invention of machine-made machinery a hundred years ago but it underwent very rapid development during the Great War, when its rigorous application was responsible for the immense productivity of the British munition factories and the American shipyards '* Furthermore, admiration of the advance of the Americans in this field is no new thing †

Standardization has a number of aspects, but one could assert that all aspects of it have a bearing on industrial efficiency A distinction has been made between functional and dimensional standardization ‡ Functional standardization includes all standards dealing with fitness for purpose They may be standards that deal with terms and definitions to secure accuracy of description and to prevent confused thinking They may deal with quality—to measure fitness for purpose Standards under this heading are based on

* D H Robertson, *The Control of Industry*, London, 1928, p 18

† It has been recently recalled that almost a hundred years ago at the time of the Great Exhibition, and at the outbreak of the Crimean War, a commission was sent by the Ordnance Department to discover how far American methods might be adopted to increase the output of small arms Among those who reported with enthusiasm on American practice at this time was the famous engineer, Joseph Whitworth What in particular was admired was 'the eager resort to machinery wherever it could be applied' and the adoption of the 'manufacturing principle', production in large numbers of standardized articles on a basis of repetition, mass-production applied to a surprisingly wide field of production, small arms, clocks, locks, and other hardware, window frames, doors, carts, etc See *Contact*, Spring, 1946, p 78

‡ Sir H F Heath and A L Hetherington, *Industrial Research and Development*, London, 1946, p 333

composition or performance. Again they may mean methods of test or methods of use (codes of practice).

We are more concerned at present with dimensional standardization which seeks to achieve (*a*) simplification, (*b*) unification, (*c*) interchangeability. When the movement towards this type of standardization started in the United States after the last war it was called by the less sophisticated name of 'simplification' or 'simplified practice' * This simplified practice means the reduction of variety in sizes, dimensions, and immaterial difference in everyday commodities. On the basis of the experiences of the first world war it was realized that the advantages of mechanical production in general and of mass production in particular cannot be realized without bulk production of 'standardized' products by the long run of machinery. In many ways, of course, standardization within the firm is relevant, but this cannot be separated entirely from standardization within the industry

The whole question of standardization and of its different aspects would require a careful analysis We do not know what the degree of standardization is in the two countries (U K and U S), what the potentialities are, what their quantitative effect is on output per worker, or why standardization has gone further in the U S. than in this country Is the greater standardization in the United States due to sociologically determined factors, to a desire to conform to a uniform pattern by people of different racial origin? Or is it due to high-pressure advertising in the U S. with a view to securing a big volume of output for mass production?

Some scattered data only are available which show that this simplification process has gone a long way in the U S, that in many fields it has gone further than in Britain, and that it does affect output per head favourably.

(*b*) In the U.S. the National Bureau of Standards issues a list from time to time which indicates the reduction in the variety of size and shape of different common commodities A few examples from the 1937 list will indicate the range of standardization of the product within individual industries † Variety in size or shape, etc, has been reduced·

Blankets	from 78	to	11
Duck, cotton	460		94
Textiles, cotton, hospital and institutional	454		26
Steel sheet	1,630		209
Fruit cans	200		21
Milk bottles	49		4
Common brick	75		2

(*c*) One of the industries where standardization of parts and accessories has gone very far is the making of electrical appliances. The types of electric lamps were reduced in the U S. from 55,000 in 1900 to 342 by 1923 through standardization of voltages and bases. 'This eliminating of types has made it possible to develop and adopt high-speed machinery for lamp making.

* See the Balfour Report (*Report of the Committee on Industry and Trade*), *Factors in Industrial and Commercial Efficiency, being Part I of a Survey of Industries*, H M Stationery Office, 1927, Chapter III.

† See Circular Letter LC 501, 2 September 1937, of the National Bureau of Standards, quoted in T.N E.C Monograph No 22

These machines eliminated practically all costly hand operations and made better lamps in larger quantities and at lower prices.'* In Britain the number of voltages is known to be greater than in the U.S., although it has been reduced recently.

Motor-cars are an even more impressive example. In the U.S. the market in motor-cars is perhaps ten times as big as in Britain. In 1939 total sales in the U.S. amounted to 2·7 millions, in Britain to 0·3 million; in the U.S. the three leading models accounted for 54% of total sales (these models being produced in a volume of 350,000 to 600,000 each). In Britain, according to trade estimates, the three leading models amounted to 27% of the sales (i.e. accounted for altogether 81,000 cars).

In the U.S. the three leading companies produced in 1939 89% of all cars. In the U.K. the three leading makers produced about two-thirds of the output and eight makers produced about 88%. The three leading companies in the U.S. produced for their 10 leading models (88% of the output) 15 engine types. In Britain the eight leading makers accounting for 88% of the sales produced 39 different engine types.†

(*d*) There is of course a strong presumption that the far-reaching standardization in motor-cars, electric lamps, soap, etc., is to a certain extent responsible for the higher U.S. output per worker, but no exact measurements were made. But in one or two cases we get some idea of the reduction of man-hour requirements through standardization. The U.S. Jantzen knitting mills switched over to the production of swimming suits of one quality instead of a variety of knitted goods. After the change an operator turned out an average of 45 seams instead of the former 9.‡ Some experience has been gained in this field of simplified practice by Britain during the late war by switching over to so-called utility production. The Cadbury firm, accounting for a high proportion of chocolate confectionery output, reduced the number of lines and packings from 237 in 1939 to 29 in 1942 with a 40% reduction in labour requirements per ton (as well as savings in factory space and paper).§ Part of it is, of course, due to reduction in quality in the sense that block chocolate has been produced instead of other types.

Lastly, reference should be made to the reports of the Working Parties set up by the Board of Trade. Virtually all of them emphasize the importance—as well as the great potentialities—of standardization and thereby the possibility of promoting bulk production and long runs without affecting consumer's choice.||

* *Commercial Standards Monthly*, August 1930, quoted in T.N.E.C. Monograph No. 22.

† See Part II, Section I, Appendix 17, Motor-cars.

‡ Quoted by T.N.E.C. Monograph No. 22.

§ See *Industrial Record, 1919–39*, published by Cadbury Brothers Ltd., p. 39. 'It will be seen', the book says, 'that a large part of the economies which led to price reductions were due to increasing standardization, both in methods of production and in the product itself.'

|| The *Working Party Report on Cotton*, London, H.M. Stationery Office, 1946, suggests that 71% of the total piece goods production is suitable for bulk production methods. Moreover, 'even in the range of goods where great variety is required, there is room for increasing the use of the finishing processes to obtain the required variety instead of insisting on variations in cloth construction' (pp. 18-19). The *Working Party Report on Pottery*, 1946, says that 'experience confirms that the lowest costs of production are achieved by firms making long runs on a few lines, and that this factor is of greater importance than the size of the factory' (pp. 17-18).

4. GENERAL FACTORS: OTHER FACTORS THAN MECHANIZATION AND PRODUCTION TECHNIQUE AFFECTING OUTPUT PER WORKER

The material presented in the previous section has established that the amount of machinery measured in horse-power per worker, its quality, its rate of replacement, and the factors determining the use of machinery (size of the market, standardization, size of the plant) will affect output per worker in industry. We were not able to establish the exact degree of inter-relationship, but in a negative sense we have seen that there is good reason to believe that output per worker is not dependent solely on this group of factors *

There is further evidence on this point In the U S several investigations were made by the U.S Bureau of Labor Statistics into the effect of mechanical changes on output per worker. In several cases investigated, cotton textile being one of the outstanding examples, the potential effect of mechanical changes was smaller than the actual increase in output per worker, which pointed to the existence of 'other' factors †

Thirdly, in a number of industries (or firms) where the equipment is very largely identical in the U S. and U.K , e g. boots and shoes, tobacco, strip steel (or in firms producing both in the U K. and U S. in such fields as electrical appliances, soap, margarine, etc), there are still substantial differences in output per worker in the U.K. and U.S ‡

(1) It is of importance to know more about these 'other' factors and the extent to which they influence output per worker These factors, which are independent of mechanization or the technique of production, are partly 'organizational' factors, partly factors affecting the willingness and ability of the worker

In connection with the organizational factors greatest prominence should be given to the skill of management in achieving and operating the best factory organization for the purpose This includes a wide range of functions, such as planning of factory lay-out, the placing of the machinery, programming production, planning the flow of work and the interdependence of operations, planning the handling of materials, dealing with the question of supervision

* Commenting on the causes of the phenomenal increase in labour productivity in the U.S. in the 1899–1939 period, Mr Fabricant first looks at changes in the value of capital assets and other characteristics of the quantity of machinery available He then goes on to say. 'As for the increased efficiency of labor itself, the one-third drop in hours must have contributed to it In addition, of course, many of the important changes are qualitative revisions of plant lay-out, improvements in equipment, notably increases in the size of machines, accelerated speed of operation, more precise control devices, and less susceptibility to breakdown. Together with air conditioning, improvements in lighting, elimination of disturbing pillars, and other refinements of factory building and design, these qualitative advances have been so revolutionary that one might well venture the statement (though it cannot be substantiated in quantitative terms) that they have contributed as much to reducing unit labor requirements as the growth in the physical stock of productive instruments ' Solomon Fabricant, *Employment in Manufacturing*, op cit p 25

† See L Rostas, 'Productivity of Labour in the Cotton Industry', *The Economic Journal*, June/September 1945, p 200

‡ It should be realized, however, that even if the main type of equipment is identical, there may be differences in the amount and type of auxiliary equipment used which will explain some of the differences

It also includes, of course, dealing with labour and creating a good atmosphere in the factory This whole problem is receiving substantial attention at present and has obviously great potential effect on the future improvement of productivity.

Some examples of the organizational factors below indicate that our factual knowledge in all these questions is small. The points are mentioned as suggestions for further research, they also show that there is no exact dividing line between the various groups of factors.

The amount of factory space available, the age and condition of the factory buildings, and the suitability of the factory for modern types of production may come into the category of 'capital equipment'. But the planning of the lay-out of the factory and of the flow of work (internal transport) is one of the important organizational factors, largely dependent—within the limits of physical possibilities—on managerial skill In several industries for which investigations were made the effect of unsuitable factory building and bad lay-out on output has been emphasized The Pottery Report,* for example, says that 'the most important factor today in increasing output per man-hour in the potteries is factory lay-out The proportion of man-hours spent on actually processing ware is too small compared with the man-hours spent in moving the ware in process from one operation to another' (p. 4) The Platt Report† emphasized the 'unsuitability of many sheds (in the cotton industry) for highly mechanized equipment, particularly in regard to pillar spacing, lay-out of the departments, and interior shed conditions, such as lighting, driving floors, etc' (p 33) ‡

Closely connected with factory lay-out are internal factory conditions, the range of which covers safety measures, measures to comply with hygienic requirements, as well as social requirements They include lighting, heating, ventilation, as well as rest rooms, medical services, canteens, etc This factor may have some influence on the willingness and ability of the worker

(ii) A few examples can be mentioned from the third group of factors—those connected with labour It is obvious that all circumstances which affect the willingness and ability of labour to make an effort will have an influence on output per worker

(*a*) The number of hours worked is one of these factors In the course of history increased output per man-hour has been associated with a reduction in the number of hours worked It is well known that in the U S. average working hours per week are substantially lower than in Britain and output per man-hour is higher There is a prima facie case that there is some inter-relationship between the two, in fact a double relationship, i e high productivity leads to reduction of working hours and this in turn increases productivity But the exact way in which this works out is not yet fully known There

* *Working Party Report on Pottery*, 1946

† *Report of the Cotton Textile Mission to the United States of America*, March-April 1944 London, H M Stationery Office, 1944

‡ See also *Working Party Report on Boots and Shoes*, 1946, p 25, *Working Party Report on Jewellery and Silverware*, 1946, p 22, *Working Party Report on Heavy Clothing*, 1947, p 65

have been studies into the effect of changes in working hours on output per worker, but the results so far are not altogether conclusive *

(*b*) The system of wage payments is another factor which will affect output per worker. The effect of different types of bonus systems or of differences in the proportion of workers working on time rates and piece rates in the U.K and U S. may have an effect on output per worker.† This is suggested, for example, by the Boots and Shoes Report, though the report shows very great variation in output per worker even among those working on piece rates.

(*c*) Closely linked with the system of wage payments are the possibilities and the effects of the methods of work simplification (based on motion and time studies) on output per worker There can be no doubt that these methods are used to a much greater extent in the U S. than in Britain, neither can the resistance of British organized labour to some of these methods be dismissed. An objective investigation of the scientific basis of these methods and their effect on output is called for.

(*d*) Labour turnover, that is, the frequency with which workers change their place of work, is another important factor bearing on productivity.

(*e*) Lastly, the differences in the psychology of the worker in the U K and U S are also worth analysing. It is often asserted without scientific proof that the American worker works harder, or, formulated in another way, that the psychological approach of the operative to work is different It is not that the objective factors (better lay-out, longer runs, planning of work, etc) cause the operative to work fast, but 'rather that those factors enable the operatives to fulfil their one clear object, namely to earn as much as they can'.‡

* The different studies of the National Institute of Industrial Psychology are well known The U S Bureau of Labor Statistics has made a case study of 12 plants on the effect of long working hours during the war, *Studies of the Effects of Long Working Hours*, Parts I and II, by Max D Kossoris, *Bulletin* Nos 791 and 791A, 1944 'It appears', these reports say, 'that hours worked beyond 40 or 48 per week result in additional output, but at a price of continuous decreases in efficiency and marked increases in absenteeism as hours rise A point is finally reached at which the longer work schedule is no more productive, and actually may be less productive, than a shorter work schedule With few exceptions, the longer working time in the plants studied resulted in a general slowing down, not only during the added hours, but throughout the entire work-week ' This study (as well as the corresponding British studies) investigated the effect of increasing working hours on output Some scattered data are also available on the effect of decreasing working hours on increased output See *Bulletin* 474 of the U S Bureau of Labor Statistics, 1928, on data relating to the steel industry

† Recent figures indicate that the number of workers employed on piece rates in British industry is relatively low and has not increased substantially since before the war It amounted to 25% in October 1938 and to 26% in April 1947 No comprehensive American figures are available for comparison An investigation by the Bureau of Labor Statistics (covering 56 manufacturing industries which include 34,000 establishments and 5½ million workers) showed that in 1945-46 30% of all plant workers in the manufacturing industries studied were paid on an incentive basis (*Monthly Labor Review*, November 1947)

‡ See the *Report* by Mr Colvin and Mr Denton, of the Boot Manufacturers' Federation, upon their visit to the U S A., 1945

5. THE EFFECT OF INTER-FIRM VARIATIONS ON INTERNATIONAL PRODUCTIVITY COMPARISONS

Our estimates have revealed substantial differences in average physical output per head *between* the individual industries in the U.K. and the U.S. Various studies undertaken in the two countries* have shown that *within* the individual industries of each country there are equally substantial differences in the output per head of the best and the worst firm, these are as great, if not greater, as are the differences between the averages in the respective industries of the two countries. This raises the possibility of discovering the causes of international productivity differences by yet another way; that is, by comparing not only the average physical output per head of all the firms, but also the physical output per head of the best firms or of two 'ideal' firms using the best manufacturing practice then current in the respective countries Such an investigation might prove that the differences between the best firms or the best practice in the two countries is perhaps smaller than the average difference, in which case the average difference would be influenced by the fact that a higher proportion of the output was produced by firms with lower productivity. If this were the case the factors which prevent the spreading of up-to-date manufacturing techniques and enable the inefficient firms to survive would require attention But until such a variational analysis of productivity among the different firms of the same trade in the various countries is carried a little further, no attempt can be made to follow this line of argument and to measure the effect on international comparisons of the spread of productivity differences within firms.

* See Rostas, L , *Productivity, Prices and Distribution in Selected British Industries*, Cambridge, 1948, pp. 28-32 See also the investigations of L H C Tippett into the Lancashire cotton-spinning industry, referred to in the footnote on p 7 For the U S see J. M Blair, 'The Relation between Size and Efficiency of Business', *Review of Economic Statistics*, August 1942, No 3

Table 15 *Changes in horse-power equipment* available per operative in the U K and U S* §

Year	United Kingdom				United States		
	Factory Trades H P per operative		All Manufacturing & kindred Trades† H P per operative		Factory trades H P per operative		
	No	Index No	No	Index No	No	Index No	
1899	—	—	—	—	2 18	100	
1907	1 37‡	100	1 46‡	100	—	—	
1909	—	—	—	—	2 88	132	100
1924	2 38	174	2 17	149	—	—	
1925	—	—	—	—	4 37	200	152
1929	—	—	—	—	4 91	225	170
1930	2 83	207	2 51	172	—	—	
1935	—	—	—	—	—	—	
1939	—	—	—	—	6 42	294	223

* Horse-power of prime movers plus that of electric motors driven by purchased electricity
† Includes factory trades, mining, and building and contracting
‡ Approximate estimates
§ Power in use per operative employed in the U K in the factory trades amounted to 2 02 h p in 1924 and 2 44 h p in 1930, and in all manufacturing trades to 2 02 in 1924 and 2 41 in 1930 (total horse-power being calculated by the British census method See Part V of the 1930 *Census of Production*, p 123)

Table 16 *Distribution of horse-power in use in manufacturing industry in the U K and U S*

	U K 1930 (%)	U S 1939*	U S 1929
		(Rated capacity—%)	
Metals	26 6	28 7	25 8
Engineering	17 5	13 0	14 2
Chemicals	5 5	12 2†	9 7†
Textiles	25 2	7 3	9 9
Clothing	1 1	0 5	
Leather	0 7	0 9	1 0
Clay and stone	4·9	6 0	6 8
Timber	2 5	7 2	8 8
Paper and printing	6 3	9 7	9 1
Food, drink, tobacco	6 4	11 5	11 0
Miscellaneous	3 3	3 0	3 5
Total	100 0	100 0	100 0
'000 h p	10,139	50,452	41,778

* No allowance is made for differences in industrial classifications as their effect is insignificant
† Including petroleum refining

Sources. Britain: *Census of Production*, 1930 U S *Census of Manufactures*, 1939, *Census of Manufactures*, 1929 (excluding railroad repair shops)

Table 17 *Horsepower per worker in selected U.K and U S industries*

	U K 1930 (H P in use)	U S 1929 (H P installed)	U S 1939 (H P installed)	H P per worker Ratio of U K to U S 1929	H P per worker Ratio of U K to U S 1939	Output per worker Ratio of U K to U S	H P per unit of output Based on 1929 (U S) 1930 (U K) h p ratio	H P per unit of output Based on 1939 (U S) 1930 (U K) h p ratio
				(U K = 1)		(U K = 1)	(U K = 1)	
(1) Pig iron / (2) Steel smelting and rolling	14 0	18 0	24 6	1 3	1 8	1 7	0 8	1·1
(3) Iron foundries	1 8	4 0	5 7	2 2	3 2	1 6	1 4	2·0
(4) Machinery								
Mechanical Engineering	2 5	—	5 0	—	2 0	2 7	—	0 7
Electrical "	1 6	—	4 0	—	2 5	—	—	0 9
(5) Cement	15 0	35 7	51 7	2 4	3 4	0 9	2 6	3 8
(6) Brick	2 8	5 7	8 3	2 0	3 0	1 3	1 5	2 3
(7) Coke	6 4	19 2	27 6	3 0	4 3	2 0	1 5	2 1
(8) Seed crushing	6 5	17 0	20 4	2 6	3 1	1 2	2 2	2 6
(9) Cotton Spinning	5 6							
Weaving	1 7							
(Spinning and Weaving)	3·4	5 3	4 8	1 6	1 4	1 8	0 9	0 8
(10) Woollen and Worsted	2 0	3 9	3 7	1 9	1 8	1 3	1 5	1 4
(11) Rayon Making			9 4			1 4	—	—
Weaving			2 0			1·5	1 1	1 9
(Making and Weaving)	1 6*	2 5	4 7	1 6	2 9			
(12) Linoleum Linoleum			8 2					
Artificial leather			4 6					
(Linoleum and Artificial leather)	4 4		6 9		1 6	1·6	—	1 0
(13) Paper	9 1	23 2	28 0†	2 5	3 1	2 5	1 0	1 2
(14) Rubber tyres	3 8‡	5 6	10 3	1 5	2 7	2·9	0 5	0 9
(15) Tin cans	0 9§	2 5	4 0	2 8	4 4	5 2	0 5	0 8
(16) Glass containers	2 3‖	4 7‖	5 4	2 0	2 3	2 6	0 8	0 9
(17) Motor cars	1 2	3·5	5 6	2 9	4 7	3 0	1·0	1 6
(18), (19) Wireless sets and bulbs	1 6**	2 7**		1·7	—			
Wireless sets			1 7			3 5	0 5	—
Electric bulbs			2 3			5 4	0 3	—
(20) Boots and shoes	0 4	0 7	0 7	1 8	—	1 4	1 2	—
(21) Hosiery	0 3	0 9	0·8	3 0	2 7	1 7	1 8	1 6
(22) Breweries	1 8	—	9 8	—	5 4	2 0	—	2 7

Table 17—*continued*

	U K 1930 (H P in use)	U S 1929 (H P installed)	U S 1939 (H P installed)	H P per worker Ratio of U K to U S 1929	H P per worker Ratio of U K to U S 1939	Output per worker Ratio of U K to U S	H P per unit of output Based on 1929 (U S.) 1930 (U K) h p ratio	H P per unit of output Based on 1939 (U S) 1930 (U K) h p ratio
				(U K = 1)		(U K = 1)	(U K = 1)	
(23) Tobacco Cigarettes	} ·4		2 2	n a		n a	n a.	
Pipe tobacco			2 3					
Cigars			0 4					
(24) Soap	2 0††	3 2	7 0	1 6	3 5	2 9	0 5	1 2
(25) Margarine	—	—	10 6	—	—	1 5	—	—
(26) Matches	1 2	4·8	4 5	4·0	3 8	3 3	1·2	1·1
(27) Biscuits and bread Biscuits	} 0·8	1 8	{2 6} 1 9	2 2	2 4	3 4	0 6	0 7
Bread			{1·8}					
(28) Beet sugar	5 4	13 1	21·0	2 4	3 9	1 2	2 0	3 2
(29) Grain milling	6 8	23·3	22·6	3·4	3 3	1 7	1 0	2 0
(30) Fish curing	0 2	1 6	2 7	8 0	13 0	0 5	16 0	27 0
(31) Ice	17 6	33 5	64 9	1 9	3·7	2 3	0 8	1·6

n a =not available

* Rayon and Silk † Including pulpmills ‡ Rubber industry as a whole, the same group for U S 1929 = 6 2 § Hardware and hollow-ware ‖ Glass industry as a whole. ** Electric engineering †† Soap, candle, and perfumery, the same group for U S. 1925 = 2 8

Notes. (*a*) British categories of trade compared with nearest U S category, owing to changes of classification, the U S 1929 and 1939 data are not strictly comparable.

(*b*) In this table U K figures relate to horsepower in use which, for reasons stated elsewhere, is perhaps a better index of available useful capacity than horsepower available (The latter may include horsepower of obsolete machinery)

For the U S , data are available for 1939 on horsepower of prime movers idle The average for the industry was 10%. The following percentages obtained in industries in which we were interested machinery, 12%, electrical machinery, 8%, cement, 10%, iron and steel, 8%, motor cars, 5%. No data are available on idle electric motors

Table 18 *Average size of establishment and size of industry in selected U.K and U S trades*

	Size of Industry		Average Size of Establishment			
			Number of Operatives			
	Size of U S Industry (Output in U K =1)	Year of comparison	U K	U S		
	(1)	(3)	1935 (4)	1935 (4)	1937 (5)	1939 (6)
(1) Pig iron	4 4	1937–7	303	—	265	241
(2) Steelworks and rolling mills	3 9*	1937–7	386‖	—	1,653‖	1,458‖
(1)-(2*a*) Blast furnaces, steelworks and rolling mills, including wire and wire products	—	—	193	—	379	299
(3) Foundries, iron and steel	2 5	1935–5	117	—	—	83
(4) Machinery	4 9†	1935–7	115**	—	77**	55**
			399††	—	209††	131††
(5) Cement	2 2	1935–5	127	135	167	149
(6) Brick	0 4	1935–5	50	24	—	36
(7) Coke	3 8	1935–7	114	—	219	194
(8) Seed crushing	1 4	1935–9	199	—	—	36
(9) Cotton Spinning	2 8†	1937–7	216	—	352	202‡‡
Weaving		—	152	—	—	472‡‡
(10) Woollen Worsted	1 0	1937–7	150	254	249	228
(11) Rayon Making	2 2	1939–9	1,800	1,580	1,670	1,611
Weaving	2 6‡	1935–7	172§§	214	243	254
(12) Linoleum and oilcloth	1 6	1935–9	284	—	—	413‖‖ 110‖‖
(13) Paper	5 2	1935–9	204	—	—	173
(14) Rubber tyres	7 9–9 0	1935–7	725	—	1,376	1,021
(15) Tin cans	10 1	1937–7	162	—	—	128
(16) Glass containers	4 8	1935–9	243	—	—	334
(17) Motor-cars Assembly	—	—	785	1,215	1,485	—
Total	9 2	1935–5	233	405	444	347
(18) Wireless sets	5 6	1935–7	294	—	—	194
(19) Electric lamps	6 8	1935–7	196***	—	—	175
(20) Boots and shoes	2 9	1935–5	134	197	199	204
(21) Hosiery	3 2	1937–7	112	119	128	113
(22) Breweries	1 5	1935–5	94	59	72	60
(23) Tobacco Cigarettes	2 2	1935–5		784	—	—
Pipe tobacco	6 7	1935–5	303	70	—	—
Cigars	84 0	1935–5		85	—	—
(24) Soap	2 7	1935–9	274	72	76	65
(25) Margarine	1 0	1935–5	178	—	—	55
(26) Matches	4 8	1935–5	113	211	210	194
(27) Biscuits	2 9	1935–9	372	—	—	82
(28) Beet sugar	2 9	1935–9	249	—	—	122
(29) Grain milling	1 9	1935–7	46	—	—	12
(30) Fish curing	0 2	1935–9	21	—	—	17
(31) Manufactured ice	24 9	1935–5	21	5	5	4

* Based on output of raw steel
† Based on value of output converted at official rates
‡ Based on output of cloth
§ For Britain, total amount of cloth made
‖ Steel-rolling only For the U S , only integrated mills
** 'Mechanical engineering' and 'machinery' respectively
†† 'Electrical machinery' and 'Electrical equipment' respectively.
‡‡ Independent yarn mills and integrated mills respectively, the average of the two would be 380
§§ Silk- and rayon-weaving
‖‖ Linoleum and artificial leather respectively.
*** Wireless valves and electric lamps

Notes (*a*) The size of industry is based on comparative size of physical output as calculated for purposes of individual industry comparisons
(*b*) The size of establishments is based on actual (for some British industries estimated) number of workers in the industry divided by the number of establishments.

Table 19. *The size of the market and the size of the average plant: a British–Swedish–Dutch comparison*

Trade	Size of market (U K = 100)	Size of average plant (No of operatives) Sweden	U K	Ratio of output per worker (U K = 100)
(a) Sweden				
Cement	15	127	127	90
Cotton weaving	5	150	152	84
Boots and shoes	7	42	134	68
Tobacco	*	250	303	†
Margarine	30	29	178	100
Beet sugar	53	n a	340	43
Wheat milling	8	9	46	95
Paper	43	207	204	140
(b) Holland				
Cement	6	n a	—	170
Bricks	22	,,	—	86
Rayon	18	,,	—	81
Soap	19	,,	—	228
Breweries	4	,,	—	90
Margarine	34	,,	—	62

n a = not available

* The figures for the different branches of the Swedish tobacco industry are Cigarettes. 3, Cigars and whiffs 137, Pipe tobacco, chewing tobacco, and snuff 23, U K = 100

† See Part II, Section I, Appendix 23.

	United Kingdom (1935) Proportion of employees in			United States (1939) Proportion of operatives in		
	small (up to 100)	medium (100-999) establishments	big (1,000 and over)	small (up to 101)	medium (101-1,000) establishments	big (1,000 and over)
(1) Pig iron	4	56*	40†	10	56*	34†
(2) Steelworks and rolling mills	4	39	57	0 3	15 8	83 9
(1)-(2a) Blast furnaces, steelworks and rolling mills, including wire and wire products	11	35*	54†	6	18*	76†
(3) Foundries Iron and steel	21	62	17	29	71	—
(4) Machinery Mechanical	19	51	30	26	47	27
Electrical	4	24	72	12	43	45
(5) Cement	15	53*	32†	13	87	—
(6) Brick	60‡	40‡	—	81	19	—
(7) Coke	19	81	—	6	94	—
(8) Seed crushing	10	43*	47†	85	15	—
(9) Cotton Spinning	7	83	10	8§	85§	7§
Weaving	15	79	6	2§	60§	38§
(10) Woollen Worsted	16	72	12	7	60	33
(11) Rayon Making		Not available	—	—	13‖	87
Weaving		Not available		8	56	36
(12) Linoleum, oilcloth Linoleum	7	26‖	67††	4	25*	71†
Artificial leather	—	—	—	23	73	—
(13) Paper	9	76	15	13	79	8
(14) Rubber tyres		Not available		1	25	74
(15) Tin cans	13	46*	41†	17	52*	32†
(16) Glass containers		Not available		3	45*	52†
(17) Motor cars	9	33	58	4	23	73
(18) Wireless sets‡‡	6	28	66	7	48	45
(19) Electric lamps	12	34**	54††	12	88	—
(20) Boots and shoes	19	66	15	8	83	9
(21) Hosiery	24	65	11	18	65	17
(22) Breweries	31	54	15	45	55	—
(23) Tobacco	6	35	59	10	38	53
(24) Soap		Not available		13	58	29
(25) Margarine		Not available			Not available	
(26) Matches	15	85	—	12	88	—
(27) Biscuits	4	30	66	21	60*	19†
(28) Beet sugar	3***	97***	—	23	77	—
(29) Grain milling	46	47*	7†	72	28	—
(30) Fish curing	94	6	—	52	48	—
(31) Manufactured ice	71§§	29‖‖	—		Not available	

* 100–499 (101–500)
† 500 and over (501 and over)
‡ Building-bricks only Based on a sample of establishments
§ Independent yarn mills and integrated mills respectively
‖ Includes two establishments with less than 100 operatives
** 100–749
†† 750 and over
‡‡ For U K radio valves and electric lamps
§§ Up to 49
‖‖ 50 and over
*** Sugar and glucose

CHAPTER VI

PRODUCTIVITY AND REAL INCOME COMPARISONS

1. THREE WAYS OF COMPARING REAL INCOME PER HEAD

By comparing the volume of industrial output and industrial employment of the U.K., U.S., and Germany in the pre-war year of 1937, it can be estimated that industrial productivity—as measured in physical production per head—was roughly similar in Great Britain and Germany, while in the United States it was more than twice as great as in the two other countries. This means that with their respective capital equipment then in existence, the Americans succeeded in producing twice as much wealth per head in manufacturing industry as did either Great Britain or Germany.

At the same time it can be observed that real income per head, as shown by other evidence, was not significantly greater in the United States than in Britain. It is of great interest to find out why the average American standard of living was not much higher than the average British standard, in spite of the very great advantage of the Americans in industrial productivity.*

In this chapter an attempt will be made to reconcile the differences in production per head in manufacturing and in real income per head by means of an analysis of productivity of labour in other branches of the national economy. This analysis is necessarily sketchy, and should be regarded as a contribution to the solution of the problem rather than as a final solution

There are three ways in which real income per head in different countries can be compared.

(i) By comparing the national income per head converted into the same currency at the appropriate rate of exchange †

(ii) A second way of comparing real income per head is by comparing the relative consumption levels of the final goods and services Such a comparison has been attempted during the war to illustrate the impact of the war on civilian consumption levels This study compared the relative consumption levels of a wide range of goods and services (food, drink, tobacco, fuel, clothing, household goods, housing, motor vehicles and their operation) accounting for a little over 75% of average total consumption expenditure in the U K. and a little less than 74% of the average total consumption expenditure in the U S. Combining these different categories and taking into

* The average standard of living of the American industrial worker is, of course, higher than the average standard of living of the British industrial worker Average weekly earnings in October 1938, just before the war, were 1 8 times as high in the U S as in Britain, and they were 2·3 times as high in October 1947. The dollars are converted into pounds at the official rate of exchange The difference in the standard of living of the American worker is smaller than these figures suggest owing to the smaller differences in the average weekly earnings of adult men, to the somewhat larger number of wage earners per family in Britain and to the more favourable rate of exchange in terms of the products entering into the cost of living But the difference still remains substantial.

† Thus Mr. Stone estimated that in 1938 the per capita national income of the United Kingdom amounted to £97 and that of the United States to £103. This has been arrived at by dividing the national income, reduced to a common currency, the £ sterling at the average (official) rates of exchange, by the total population of each country. The national income is taken as the sum of the receipts accruing to individuals and institutions, private and public authorities normally resident in the United Kingdom, and which accrue from work or the use of property for productive purposes. (See J R. N. Stone, 'The Measurement of National Income and Expenditure', *The Economic Journal*, September 1947, p 297)

consideration the possible relative purchasing power of the pound and the dollar for the types of consumption (mainly services) not covered by the comparison; this study suggests that in 1938 and 1939 the physical volume of consumer purchases was probably between 10 and 20% lower in the United Kingdom than it was in the United States.*

(iii) The third method of comparing real income in different countries—the one which will be attempted in this chapter—is by comparing the productivity of labour in the different branches of the national economy. Before we proceed, however, from productivity comparisons to real income comparisons, a number of other factors also have to be considered. The most important of them is the distribution of working population between different industries. The per worker contribution of the several industries to the national output within the same economy will vary. Therefore it is possible that, although one country achieves a higher physical output per head than the other in all branches of the economy, it will nevertheless have a smaller real income per head owing to differences of distribution in working population The most striking example of this is the high proportion of agricultural population in the U S. with a higher physical output per head than in British agriculture, but with a lower contribution to the national income than either the British or the U.S industrial worker

Another factor which enters into real income comparisons between countries is differences in the proportion of working population to total population and in the number of hours worked by the working population. There may not be great differences in the proportion of able-bodied men working, in relation to the total number of such men, from country to country, but there will be differences in the proportion of women working, in the proportion of young people working or in the proportion of aged people working. There will also be, of course, differences in the number of hours worked. These proportions will be determined by the wealth of the country, economic progress (influenced by productivity), customs, habits, climate, institutions (such as the school leaving age, etc). In cases where normal working hours are shorter, or a smaller proportion of women is working or children start working only at a later age, the people in the country concerned are really having part of their real income in the form of leisure Differences in the proportion of the working population unemployed (i.e. an involuntary form of leisure) also affect real income comparisons

A third group of factors may leave the comparison of national output unaffected, but would influence the output of consumable goods and services and thereby real income per head In some countries high productivity may have been achieved in all industries, but only at the cost of using considerable effort in the roundabout ways of production without increasing the output of final goods. For example, output per worker might be high in most manufacturing industries, but only at the cost of using a great deal of extra labour indirectly in making and replacing machines and equipment Or output per worker in any of the industries might be high because of large-scale produc-

* See *The Impact of the War on Civilian Consumption in the United Kingdom, the United States and Canada*, London, H.M. Stationery Office, 1945, especially Appendix XI.

tion, but this could be achieved only by using a great deal of extra transport Or again output per worker might be high because mass production methods are employed in such a way that a big cadre of maintenance and repair workers has to be kept in existence

Another set of factors which enter into real income or standard of life comparisons, although they do not find quantitative expression, relate to the goods and services (mostly services) provided by the people for themselves. The work of the housewife in countries where domestic service is no longer customary is one example Private motoring as a means of passenger transport is another one.

If a real income comparison is made on the basis of comparing productivity of labour, these additional factors entering into the picture will also have to be considered.

In the following section an attempt is made to compare productivity of labour in the non-manufacturing industries, while the last section of this chapter deals with a reconciliation of productivity comparisons and real income comparisons.

In Chapter II there were set out the many difficulties which the research worker encounters in making comparisons of productivity in manufacturing industries. Most of the difficulties enumerated there and the consequential limitations on the reliability of the estimates also apply to productivity comparisons in non-manufacturing industries These latter comparisons are in many ways an even more difficult problem, mainly because in most cases no physical measurement of the output is possible As these difficulties will vary from industry to industry, they are better discussed separately when dealing with the several non-manufacturing industries.

2. A COMPARISON OF PRODUCTIVITY OF LABOUR IN THE NON-MANUFACTURING SECTORS OF THE BRITISH AND U.S. ECONOMY

(i) *Agriculture and fisheries*

(a) *The comparison of productivity of labour in agriculture*

The question of how physical output per head of the working population compares in the agricultures of the U.K., the U.S., and Germany requires a more detailed examination.

Germany has been included in this consideration for the reason that it helps to draw attention to some of the factors affecting comparisons of productivity in agriculture.

Such a comparison is not an easy task, as agriculture has not the same position in the economic system of the three countries and consequently their structure of agricultural production is very different To a certain extent, therefore, we are comparing industries that are almost heterogeneous. Britain has a unique position. Not more than one-twentieth of her working population is engaged in agriculture, and in consequence British agriculture specializes to a considerable extent—at least in normal peace-time years—on the production of a limited range of products, and Britain imports the bulk of her

requirements of agricultural products. The U.S., on the other hand, employs nearly one-fifth of her total working population in agriculture, and has a surplus in agricultural products. Again, the structure of German agriculture is not quite comparable with either the British or the American, although its proportionate importance—employing one-quarter of the working population—is greater than that of the U.S. The U.S., however, not only produces all the types of products produced in Germany and in the U.K., but in addition, owing to her diverse climatic conditions, produces virtually the whole range of agricultural products, such as citrus fruit in California, and, what is more important, a vast amount of cotton in the Southern States. Under such circumstances it is difficult to express the volume of output of agriculture in each of the three countries in one set of comparable figures.

One way of tackling the problem is to take the money values of the net output of agriculture in the three countries and convert them into the same currency (£ or $) by estimating the exchange rate which expresses the relative prices of agricultural products in the three countries. The net output of agriculture—which is similar to the concept of net output of industry—indicates the value added by agriculture to the materials, etc., used in agriculture. This can be arrived at by deducting from the gross value of agricultural production such items as costs of feeding stuffs, livestock, seeds, fertilizers, machine repairs, machine fuel, etc. Care has to be taken, of course, that the gross output does not contain double counting, e.g. it should not include inter-farm transactions or the value of output of feeding stuffs which are used for feeding livestock, but gross output should on the other hand include, in addition to the value of sales, an amount corresponding to the value of products consumed on the farms. The exchange rate in terms of agricultural produce can be arrived at by calculating the ratio of the prices of as many individual agricultural products as possible, and then weighting these single ratios by the relative importance of the individual products in the total agricultural output in the different countries. It can be estimated that the purchasing parity rate in terms of comparable agricultural products for 1937 (by using U.S. weights) would be $3·52 and Rm 16·86 to the £ respectively. On the basis of these conversion rates, the value of net output of British agriculture, which amounted to £175 millions in 1937-8, could be compared with the value of net output of U.S. agriculture (in 1937) amounting to £1,807 millions, and with the net output of German agriculture (in 1937-8) amounting to £628 millions.* Thus the output of British agriculture in the years indicated was about a tenth of U.S. agricultural output and little more than a quarter of German agriculture.

The second problem is to estimate the labour force in the three countries

* Two points have to be observed (i) The above exchange rates were arrived at by using U.S. weights when calculating the price index. If British weights were used in the U.K.–U.S. comparison, and German weights in the U.S.–Germany comparison, the relative size of output would be U.K. 100, U.S. 1,358, and Germany 336, instead of U.K. 100, U.S. 1,030, and Germany 356, as above. (ii) The ratio of net output to gross output is different in the three countries, it is lowest in the U.K., indicating that the quantum of agricultural operations may be different in the three countries (i.e. it is perhaps lower in the U.K. than in the two others)

which was responsible for the production of the above agricultural output. This again cannot be done very precisely, in view of the fact that farming is a way of life as well as a way of making a living. The main—though not the only—difficulty is to determine how far the work of female members of the family should be included or excluded when estimating the total labour force working in agriculture. The British and American censuses take—quite correctly—a narrow view in this respect They do not include the farmer's wife, and in any case in Britain and the U S the proportion of female family helpers—and of females in general—in the agricultural working population is so small that their inclusion or exclusion would not affect the general picture The German census, on the other hand, takes a wider view, and classifies most of the wives as family helpers For this and a number of other reasons (e.g. the predominantly peasant character of most of German farming, the fewer alternative occupations in industry, etc) a high proportion of the German labour force appears to consist of females in general and of female family helpers in particular. In comparing the labour force in the three countries, allowances have been made for most of these factors, and it is found that after taking account of independent farmers and family members giving help, in so far as this is legitimate, as well as of permanent and seasonal farm-workers, the total number of persons working in agriculture can be put at 10 8 millions in U.S , at 1 1 millions in Britain, and at 8 5 millions (or, excluding wives, at 6 9 millions) in Germany.

By relating employment data to output data it is calculated that in 1937 output per head in American agriculture amounted to about £166, in British agriculture to £159, and in German agriculture to £74 (or, excluding wives, to £91). This means that broadly speaking,, physical output per head does not differ substantially between the U.S and U.K. (though it may be slightly higher in the U.S.), while in Germany it is perhaps half as high as either in the U K. or in the U S (see Table 21).*

* For basic tables see Part II, Section II, Appendix 32

Table 21 *Comparison of productivity in agriculture, United Kingdom, United States, Germany*

Agriculture	U S 1937	U K 1937-8	Germany 1937-8
Value of net output	$6,361 mn	£175 mn	Rm 10,584 mn
Estimated employment	10,892,000	1,100,000	8,500,000 or 6,900,000*
Net output per head			
In agriculture—			
(a) in original currencies	$584	£159	Rm 1,245 or Rm 1,534*
(b) at official exchange rates of 4 94 and Rm.17 08 to £	£118	£159	£73 or 90*
(c) at purchasing parity rates, 3·52 and Rm.16 86 to £	£166	£159	£74 or 91*
(d) as index numbers	104	100	47 or 57*

* After deducting 1,600,000 wives, included as family helpers (on the assumption that three out of every four wives were originally included in the census data) If the labour force were expressed in equivalent 'men', Germany would compare more favourably with the U K and S.U

There is another—though less reliable—method by which the relative output per head in the three countries can be calculated. This method confines the comparison to purely physical quantities and compares only that part of the output (i.e. those ranges of products) which are produced in all the three countries and for which quantitative data are available. On this basis the volume of agricultural production in England and Wales, covering about 80% of the value of output, can be compared with the volume of agricultural production in the U S, covering about 75% of the value of output. Such products as fruit, vegetables, cotton, tobacco, soya beans, peanuts, etc, have been excluded from this comparison The main difficulty in applying this second method is to estimate the number of people who can be regarded as responsible for the output of this limited range of products. Such estimates are conjectural. They have been based, broadly speaking, on the assumption that the value of output per head in respect of different types of products is the same On this basis it can be conjectured that, in the U S, approximately 9-10 5 times as great a physical output is produced by about 10 times as many people as in England and Wales This largely confirms the results of our first estimate.

No great accuracy can be attached, of course, to either of these two estimates, but it is clear that the difference between productivity of labour in the U S. and U K. agriculture cannot be great This means that while each of the ten million industrial workers makes at least twice the contribution to the U.S. national output that the average British industrial worker makes to the British national output, the average contribution of the almost equally numerous American agricultural worker is broadly on the same level as that of British agricultural workers

(*b*) *Long-term changes in productivity of agriculture*

It is interesting to compare the rate of increase in productivity of labour in British and American agriculture as well as the trends of labour productivity in agriculture and in industry in the two countries.

Between 1908 and 1936-7 output increased by about 30% per head and perhaps somewhat over 40% per man-hour in British agriculture; in the comparable period of 1909 to 1937 the increase in American agriculture amounted to 58% per head, and perhaps 66% per man-hour. In other words, the rate of increase per head per annum was a little over 2% in the U.S. and only 1% in Britain Between 1937 and 1944 there was a further 18% increase in output per head (and perhaps somewhat less per man-hour) in American agriculture; in Britain the estimated war-time increase per man-hour has been put at 13%, i e the increase has been less than in the U.S, so that the comparison of productivity of labour relating to present-day conditions would be less favourable to the U.K *

* Long-term changes in productivity per head in U S agriculture have been estimated by H Barger and H H Landsberg, *American Agriculture*, 1899-1939, New York, 1942, and by the Bureau of Labor Statistics The estimates above are from the second source mentioned As data on hours of labour per year are inadequate—following Barger and Landsberg—it has been assumed that the hours were 5% higher in 1909 than in 1937 For Britain the available information is scanty. The figures were based on data given in (1) *British Agriculture* (a Report of an Enquiry organized by Viscount Astor and B Seebohm Rowntree), London, 1938, pp. 53 and 306, and (2) C Clark, op cit, p 255 For lack of more precise data it has been assumed that working hours were about 10% higher in 1908 than in 1936-7 War-time changes in British labour productivity are based on information given by J H Kirk, 'The Trend of British Agriculture during the War', *Proceedings of the Agricultural Economics Society*, 1946.

It is also worth noting that the increase in industrial productivity appears to be greater in both countries than the increase in agricultural productivity In the U.S. output per worker in manufacturing increased by 65% between 1907 and 1937, in the U.K by perhaps 47%. The increase in output per man-hour has, of course, been even more pronounced both in U S and British industry It is estimated at 133% in the U S and can be put at 65% in the U K. In both cases one of the important developments was the decrease in actual working hours in industry, which was probably less pronounced in agriculture.

(c) *The interpretation of comparative productivity in agriculture*

It is necessary to emphasize again that the main purpose of comparing productivity of labour in agriculture has been to ascertain what contribution is made by agriculture to real income in the two countries, taking the distribution of the working population and capital equipment used as given This comparison obviously throws light on the relative efficiency of labour in the two agricultures. But before a final picture of the relative efficiency of farming in the two countries can be arrived at, agricultural output in the two countries has to be related not only to the utilization ('input') of labour, but also to that of other factors of production In other words, the relative use of machines per worker (or the output produced per unit not only of direct but also of indirect labour employed in making machinery), as well as the relative output per acre has to be taken into account Moreover, if we discuss efficiency of farm labour in general, it is doubtful whether the U S is our most relevant standard of comparison In comparing productivity of labour in industry, the U S. represents the highest level so far attained, and it also represents our potential supplier as well as our potential competitor in industrial goods But in agriculture U S productivity appears to be surpassed by other countries with which we trade, notably New Zealand, Australia, and the Argentine *†

(d) *Productivity in fisheries*

A crude comparison of total weight of fish caught (irrespective of kind and type) and employment data gives an output per worker of 79 for the U S, taking U.K.=100 The details of calculations are given in Part II

(ii) *Mining*

A comparison of output per head or per man-hour in the different branches of mining will reflect first of all the differences in the physical conditions of mining and only secondarily differences due to other factors

* Colin Clark, *The Conditions of Economic Progress*, 1940, p 246 Our estimates for U S, U K, and Germany differ from Mr Clark's only in the estimate of employment

† This is a very important fact when we try to draw conclusions from our findings on the question of a smaller or larger British agriculture The relevant consideration for this purpose is whether the output of the British industrial worker can be exchanged through foreign trade for a larger amount of agricultural produce than the same worker could produce if employed in agriculture, in both cases assuming the availability of the necessary capital equipment within the limits of national resources These alternatives will obviously depend on the relative productivity in agriculture and industry in Britain, as well as on the productivity in agriculture of our supplying countries, and lastly on our terms of trade.

Three sectors of the mining industry will be compared

(*a*) Coal mining and fuel in general.

(*b*) Iron ore mining

(*c*) All other branches of mining.

(*a*) *Coal mining*

For coal mining comparisons are available in the official statistics of the two countries These comparisons show that in the U S in 1938 output per man-shift amounted to 4 37 tons, while in the U.K. they amounted to 1 148 tons, i e U S output per man-shift was 381 (taking U K =100)

The Reid Report points out that natural conditions in the U.S are greatly superior to those found in the United Kingdom 'The high overall output per man-shift obtained in the United States is undoubtedly due to the favourable physical conditions, the excellent underground transport arrangements, the high degree of mechanisation at the coalface, and high standard of individual effort. The steady gain between 1934-45 was probably caused by the increase in the percentage of the output mechanically loaded '*

(*b*) *Fuel production in general*

The unique physical advantage of the U S in regard to energy production is not exhausted by her superior natural conditions in coal mining The U S also receives a substantial amount of energy year by year from her crude petroleum and natural gas fields, as well as from the use of water power.

The total amount of energy produced year by year from mineral fuels and water power (expressed in equivalent of bituminous coal) has been estimated The number of persons engaged in the corresponding branches of the energy-providing industries are also available (except for water power, which can be estimated).

This comparison shows that in the U S. a 15% smaller labour force than was employed in the U K produced in 1939 3 6 times the amount in equivalent bituminous coal as compared with the U K , i e output of energy per operative in the U S is about 4 2 times higher than in the U K If allowance were made for the shorter working hours the difference would be even greater.

(*c*) *Iron ore mining*

In iron ore mining physical conditions again favour the U.S. The U S. has achieved very great advances in productivity of labour in iron ore mining, which were due in the 'twenties mainly to advances in mechanization, better mining methods, operation of larger units, and more efficient management of mines. To these factors was added in the 'thirties the expansion of open-pit operations in Minnesota (the main producing State) It is an added advantage, of course, that the iron content of the U S iron ore is much higher than that of the British iron ore.

In the pre-war period output per worker of iron ore was about twice as high in the U S. as in the U K (in terms of iron contained in the ore, three times as high) Output per man-hour in the U.S. amounted to 0·925 tons in 1938, 1 325 tons in 1939, and about 1 50 tons in 1940, while in the

* See the *Reid Report* (op cit , p 50), p 29 The productivity of coal mining is a subject which has been widely discussed recently in several books, pamphlets, and articles

U K. both in 1935 and in 1938 it was approximately 0 59 tons, thus U S. output per man-hour was 2 2-2·5 times higher (in terms of iron content about 3·7 times higher)

(d) Other branches of mining

A comparison of other branches of mining (i.e except fuel and iron ore) is difficult, as the range of minerals mined differs

Broadly speaking, 220,000 persons were employed in these other branches in 1939 in the U.S (according to the last census), of which stone (41,000), limestone (28,000), copper ore (27,000), gold (23,000), sand and gravel (21,000) were the most important ones Oil and gas field services, employing 47,000 persons, are also treated as part of the mineral industry

The estimated value of net output per head amounted to $3,321 in these industries.

In the U.K. about one-third of the number of persons (over 70,000) were employed in the other branches of mining, according to the 1935 *Census of Production*. Of these, 57,000 persons were employed in non-metalliferous mining and quarries (such as stone, limestone, sand, clay, etc) and about 10,000 in slate mines

The value of net output per person employed amounted in 1935 to £191

Converting the U S. value of net output into £ at the official rate,* U.S net output per head appears to be four times higher than U K net output per head No allowance has been made for the lower working hours in the U S , which would enhance the U S advance

(iii) *Public utilities and communications*

A comparison of relative productivity of labour in these branches of the economy will necessarily be less exact than in industries producing physical products. Such measurements of output as cubic feet of gas sold or kilowatt hours of electricity sold, amount of mail handled, number of telephone calls and telegraph messages, are obviously less satisfactory than, say, a ton of cement or of pig iron. In the former case a great deal more than the physical units mentioned above constitutes the output. There are, in addition, different kinds of (mostly immeasurable) services to be considered. This factor has to be kept in mind when interpreting the comparisons

The broad picture emerging from these comparisons is as follows

	Output per head in U.S. (U K. = 100)
Manufactured-gas industry (cubic feet of gas produced and distributed)	163–173
Electricity supply and distribution (kw /hrs produced and distributed)	193
Post, telegraph and telephone (weighted average of mails, etc , handled, of telephone calls, and of messages sent)	235–303

* The official rate may not express the exact price differences of the minerals concerned, moreover the range of minerals is different, so that no exact price comparison could be made. The third factor to be considered is that some U S. branches included, e g gold or copper mining, will have a high net output per head to which no categories correspond in the U K. For all these reasons the above figure of comparative productivity is largely conjectural and probably overestimates the U S advantage

A number of reservations are necessary in all three cases

In the gas industry exact comparisons are made difficult by the fact that the U S. industry purchases part of its supplies in the form of natural gas, and is concerned only with its distribution Secondly, the importance of by-products differs in the two countries Thirdly, the U K. labour force does a great deal of construction, etc. work, while the position in the U.S is not known

The last factor mentioned is of importance in the electricity supply and distribution industry of the U.K as well

In the communication sector the activities of the Post Office in Britain are compared with the activities of the U S. Post Office and the privately operated telephone and telegraph systems *

The comparison is conjectural owing to the difficulty of calculating a satisfactory weighted average of 'output'. The proportionate importance of telephone calls is much greater in the U S. than in the U.K , but it is doubtful whether the average price per unit would express correctly the amount of labour (direct and indirect) etc , entering into its output Further difficulties arise from the necessity of ignoring the manifold other activities of the Post Office. The third difficulty arises from potential differences in the scope of activities in regard to constructional, repair and maintenance services in the two countries

(iv) *Building and Construction*

No reliable estimates are available on relative productivity of labour On the basis of some scattered data on estimated normal output per man-hour for certain operations, the Bossom Report suggests that output of labour per man-hour is, on the average, some 30% higher in the U S. than in Great Britain,† and perhaps 15% higher per worker But as the data are based on the notional, not actual, data of a few big firms, the value of the comparison is questionable

(v) *Transport*

(*a*) *Railways, buses, trams, etc.*

A comparison of output per head in the transport industries of different countries is not an easy task There are a number of competing measurements, none of which is entirely satisfactory. We can measure output

(*a*) in passengers or goods traffic carried,
(*b*) in train miles,
(*c*) in car miles,
(*d*) in passenger miles and net ton miles (i.e. the number of passengers multiplied by the average length of the journey, and the aggregate tons carried multiplied by the average haulage, alternatively, the car miles multiplied by the average number of persons per car or the average weight carried per car respectively)

* For this reason this comparison is unsuitable as an indicator of state enterprise versus private enterprise

† See *Methods of Building in the U S A the Report of a Mission appointed by the Minister of Works*, London, H M Stationery Office, 1944 Also Appendix 14 of the Report (unpublished), section 3, p 159

We have attempted to provide several alternative measurements for railways, trams, and buses, in order to indicate the trend of the relative productivity of labour. (See Table 22 for results.)

Table 22 *Productivity comparisons in different branches of the transport industry*

(a) Railways*					
		Output per person employed			
		U S		Germany	
	U K	U K weights	U S. weights	U K weights	German weights
(1) Passenger and net ton miles weighted by gross revenue	100	504	762	174	190
(2) Passenger and net ton miles weighted by average revenue	100	515	297	—	—
(3) Passenger and freight train miles	100	130	163	—	—
(4) Passenger and freight car miles	100	188		—	—
(5) Passengers and freight carried	100	84	80	—	—

(b) Motor Buses		
	U K	U S
Passenger journeys per persons employed	100	107
Bus miles per persons employed	100	280

(c) Tramways, etc		
Estimated passenger journeys per persons employed	100	113
Estimated vehicle miles per persons employed	100	190

* No allowance has been made for different proportions of those employed working on new construction, or for those employed by British railways in the delivery of goods to and from stations

(b) *Road haulage industry*

In comparing output per head in the road transport industry, further considerable difficulties arise due to:

(a) an almost complete lack of statistical data on the road haulage industry both in the U.K and in the U.S ;

(b) complications arising out of separating long-distance (inter-city) road transport from short-distance (intra-urban) road transport;

(c) the existence of a road haulage industry as well as privately owned trucks, which in many cases perform identical functions

Limiting the comparison to inter-city traffic, estimates indicate that differences between the two countries are not great Comparing the U K. road haulage industry with the total road haulage industry in the U.S., we find that approximately four times the number of persons account for four times

the ton miles Comparing the U K industry with the big road haulage firms only in the U S , we find that (taking U K = 100) about 55-60% of the persons in the U.S carry 76% (or less) of freight tons and account for about 55% of vehicle miles The margin of error in all these comparisons is very great.

(c) General comparison of productivity of transport activities

The comparisons in sections (*a*) and (*b*) give us some idea how productivity of labour compares in several branches of the transport industry in the U.K and U S

In this section the same problem will be approached by a different method It will be based on an estimate of the total number of persons engaged in carrying passengers and goods, related to the total population, and to the estimated total volume of goods to be transported

It should be noted that not all persons employed in transport have been covered by comparisons under (*a*) and (*b*) Quite apart from such special branches of transport as, say, water transport, pipe lines, air, etc., or services incidental to transport, a great many other people are concerned with transport, although they would be classified as employees of different manufacturing, building and construction, distribution or services industries

We have attempted to estimate the total number of persons concerned with transport activities (excluding those making transportation equipment) We have included all persons employed in such services as railways, trams, buses, taxis, the road haulage industry, coastal shipping and water-transport, the merchant navy, docks and harbours, canals, air; but we also estimated the transport personnel used for haulage who were employed by the producing, distribution or service industries as well as persons employed in road construction and maintenance, garage and sales operatives. The estimates are necessarily conjectural, and ignore a number of important qualifications *

The estimated total number of persons concerned with transport has been split up into those concerned with transporting persons and those carrying goods In most cases the division is obvious; in the case of railways an arbitrary decision has been made on the basis of total revenue derived from passenger and goods traffic, but in the U S a larger proportion has been allowed for passenger traffic, as it is probable that goods traffic has to subsidize passenger traffic. In case of services incidental to motor transport the employees were divided up on the basis of relative mileage covered per annum by different types of vehicles.

The 'output' which can be related to these employment estimates (freight traffic and passenger traffic respectively) is

(*a*) the total number of inhabitants for passenger traffic, and

(*b*) the volume of the output of manufacturing, mining, and agriculture, with an allowance for the volume of imports.

This 'output' has been estimated by calculating a weighted index of output

* e g part of the merchant fleet is concerned with carrying non-British trade to and from ports outside Britain, and is not engaged in transporting British trade Those employed in carrying goods for ancillary use may perform different kinds of services, as well as transport functions, which have to be ignored.

per head and then multiplying this index by the number of persons employed. For imports to Britain allowance has been made by increasing the volume of agriculture. The volume of U S imports has been ignored It should be noted that the total volume of goods distributed may not be expressed correctly by an index reflecting the volume of final products; moreover, the volume of 'services' transported (e.g deliveries and collections by laundries) has been ignored

Table 23 summarizes the results of these calculations

As can be seen, about 3 1 times as many persons are employed in transport activities in the U S. compared with the U K , about 2 1 times as many in transporting passengers, and 3 8 times as many transporting goods. The number of persons for whom transport has to be provided is, however, only 2 75 times as great, thus in the U S 1 30 persons provide transport for 100 population, while in the U.K the figure is 1 68 This comparison ignores, of course, the greater geographical distances in the U S. or the frequency of people's travels. It also ignores the fact that to a large extent in the U.S.

Table 23. *Comparison of productivity in transport activities*

		UK	US
		1937-9	
(1) Estimated number of persons concerned with transport activities*†	(million)	2 1	6·6
	(index)	100	314
Broken down into those concerned with			
(*a*) passenger traffic	(million)	0·8	1 7
	(index)	100	212
(*b*) goods traffic	(million)	1 3	4·9
	(index)	100	377
(2) Total population in 1939	(million)	47·5	130·6
(3) Value of goods to be carried		100	350-400
Broken down into			
Manufacturing		100	350
Mining		100	420
Agriculture		100	970
Agriculture and imports (in Britain)		100	300
(4) Persons employed in passenger transport activities per 100 population		1·68	1 30
(5) Volume of goods carried per person employed		100	93-106

* See Appendix 36

† It should be noted that in this and the following sections it was necessary for statistical purposes to include output and employment already dealt with in previous comparisons, e g transport workers employed in industry are included here, though they have been dealt with when comparing productivity in industry

the people provide their own transport, although it allows for the compensating factor of persons employed by garages, servicing, and so forth

In so far as goods traffic is concerned, it appears that about 3 8 times as many persons in the U S. carry 3·5-4·0 times the quantity of output, thus there does not appear to be much difference in 'output' per head The calculation again ignores the greater distances in the U.S., it also ignores the services provided by the transport personnel, which is probably higher in the U.S. than in the U.K.

This second approach to comparing productivity of labour in transport is compatible with our first approach given in sections (*a*) and (*b*) if we disregard geographical distances We then find that the number of persons employed in transport activities, in relation to the number of people who have to be provided with transport and the volume of goods to be transported, is not very different in the two countries By ignoring the greater distances in the U S (i e the greater average length of passenger journeys or of haulage), we perhaps underestimate the U S position But in this way we make allowances for potentially unproductive transport activities in the U S , which do not increase the final value of goods and services available.

(vi) *Distribution and the services industries*

In the services industries and distribution there are even greater difficulties in defining 'output' than are encountered in the transport industries

As a first approximation we can compare the number of persons employed per 100 of the total population.

Number employed per 100 *of total population**

	U.K 1939	U S 1940	U S as % of U K
Distributive trades	6 32	5 72	91
Commerce, finance, and services including civil and central government, Army and Civil Defence	8 25	6 97	84
Domestic service	3 01	1·60	53
Total	20 37	15 94	78

* *Sources Statistical Abstract for the U K and Statistical Abstract of the U S* See also C.T Saunders, 'Manpower Distribution, 1939–45 Some International Comparisons', *Transactions of the Manchester Statistical Society*, February 1946

This comparison shows that in all the tertiary industries less people are employed in the U S than in the U.K. to provide these services In the distributive trade 9% less people are needed in the U.S. than in the U.K. to provide for 100 of the population, in commerce, finance, and services 16% less, and in domestic service 47% less *

This may mean, of course, either that the U S services industries are more productive (i e less people are needed to provide the same amount of services) or that less people are employed in the U S. per 100 population because the population is provided with a smaller amount of services per head An obvious example of the latter is domestic service It is not the case that U.S domestic servants work harder and therefore that a smaller number can look after more people, the fact is that on the average less domestic service is available per head It is therefore necessary, as a second approximation, to conjecture

* U S advantage in distribution is underestimated by U S classification, which treats eating- and drinking-places as retail distribution By making allowances for this factor, U S would need somewhat less people in distribution and somewhat more in services than indicated above

the amount of services provided per head or, in the case of distribution and commerce and finance, to relate employment to the volume of trade.

(i) *Distribution* We have estimated the aggregate physical volume of output to be transported. We can relate both employment in distribution as well as employment in commerce and finance to this output, as a crude approximation

We have found that 2 5 times the number of people in the U S. as compared with the U.K (or little more if we take Great Britain) distribute 3 5-4 0 times the quantity of goods This would give an output per head index of 140-160 for the U S as against 100 in the U K.

(ii) *Commerce, finance, banking, etc* In 1939, 413,000 persons were employed in these occupations in Great Britain, in 1940, in the nearest corresponding category in the U S.—finance, insurance, and real estate—there were employed 1,468,000 persons. Some of the latter, i e those concerned with real estate, belong probably to the general services industries Also a large part of the services provided by these professions are provided for private persons, not for businesses Ignoring both these considerations, we could say that about 3 56 times the number of employed provide the commercial, financial, and other services for 3 5–4 0 times the volume of trade Thus 'output' per employed does not differ substantially in the two countries

(iii) *Services* For a great many miscellaneous services the per head pre-war expenditure has been estimated by an official survey of comparative consumption levels On the basis of the same study the exchange rate appropriate to this type of expenditure can also be conjectured *

	U K 1938	U S 1939
	per capita consumer expenditure	
	£	$
Miscellaneous services	9 96	88 76
Amusements	1 43	7 65
	£11 39	$96 41 approx £15 6–£17 7
Volume of above services consumed per head	100	137–156
Total volume of output of above services	100	390–450
Conjectural employment	100	232–239
'Services output' per employed	100	163–193

(iv) *Services and government* The services output per employed estimate is conjectural owing to the difficulty of estimating the number of employed providing these services One of the difficulties is that the services of government (such as health, education, etc) are not included in the above *per capita* expenditure figures, while on the other hand it is difficult to eliminate them from the employment figures We added the per head value of government expenditure on non-military purposes to the services expenditures per head, we converted this sum by the same rate of exchange as applied to services excluding government expenditure (which is more speculative), and then estimated the total number of persons employed in the industries providing the specific services and in government (non-military) service

* *The Impact of the War on Civilian Consumption in the United Kingdom, the United States, and Canada*, London, H M. Stationery Office, 1945, pp 55, 62, and 134

	U K 1938	U S 1939
	£	$
Services expenditure per head	11 39	96 41
Government civil expenditure per head*	9 66	99 54
	£21 05	$195 95 approx £33
'Services' per head of population (including Government provided services)	100	150
'Services' output (including Government provided)	100	430
Employment	100	250
'Services' output per employed	100	170

* Based on *Impact of the War, etc* , op cit , Table II, p 20.

3. RECONCILIATION OF PRODUCTIVITY COMPARISONS WITH REAL INCOME COMPARISONS

(i) *A summary of productivity comparisons*

The following table and chart 3 summarize the estimated comparisons of output per head in the different branches of the national economy.

Table 24 *A summary of productivity comparisons**†

For degree of reliability of estimates see notes on individual industries

		U K	U S.
		(approx. 1935–9)	
1	Manufacturing	100	215
2	Mining	100	415
	Broken down into Fuel	100	423
	Iron ore	100	206
	Other mining	100	392
3	Public Utilities and Communications	100	233
	Broken down into Electricity	100	193
	Manufactured gas	100	168
	Post, telephone, telegrams	100	270
4	Building and construction	100	115
5.	Agriculture and Fisheries	100	103
	Broken down into Agriculture	100	104
	Fisheries	100	79
6.	Transport		
	(*a*) Allowing for distances	100	(270–300)
	(*b*) Not allowing for distances	100	(100–110)
	of which Railways (*a*) Ton miles	100	400
	(*b*) Passengers and freight	100	82
	Buses (*a*) Bus miles	100	280
	(*b*) Passengers	100	107
	Trams (*a*) Car miles	100	190
	(*b*) Passengers	100	113
	Road haulage	100	(100)
	All transport activities concerned in carrying		
	(i) Passengers	100	(126)
	(ii) Goods	100	(93–106)
7.	Distribution	100	(150)
8.	Finance, etc	100	(100)
9.	Services and Government	100	(170)
	Weighted average‡		
	(*a*) Weighted by British employment	100	183
	(*b*) Weighted by U S employment	100	163

* Comparisons refer, broadly speaking, to the last pre-war years (i e the years between 1935 and 1940), but not necessarily to the same years for each pair of industries

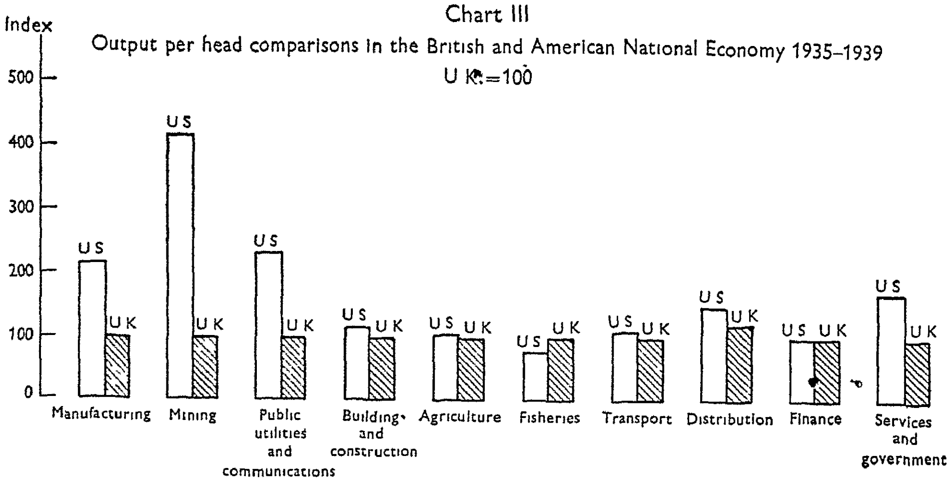
† For the sake of simplification the range of differences, due to different methods of weighting, were omitted and averages only given

‡ For Transport, estimate (*b*) was taken

Chart III

Output per head comparisons in the British and American National Economy 1935–1939

U K=100



This comparison indicates that the U S. advance in output per head is not as great in most of the branches of her national economy as in manufacturing It is higher in mining than in manufacturing, due mainly to natural conditions, and the American advance is largely on the same level in public utilities as in manufacturing. The U.S. has, however, a lower superiority in physical output per head in the services, distribution, building and construction industries, though there is still a superiority Lastly, output per head appears to be on the same level in agriculture and (on certain assumptions) in the transport industries of the two countries.

While in manufacturing physical output per head appears to be well over twice as high in the U.S. than in the U.K , in all branches of the national economy analysed this is reduced to 1 6-1 8. This goes some way already towards explaining why real income comparisons are more favourable to the U.K. than productivity of labour comparisons in manufacturing.

(ii) *The effect of differences in the distribution of the working population, and in contributions of different branches of the economy to national output*

There is another factor which enters into real income comparisons, and this is the relative levels of output per head in the different branches of the national economy. This can be measured in value terms of the respective countries, i.e by the value of the contribution which each worker makes to the national output. In agriculture, e g where these differences are the most obvious, the value of net output per worker in the U S amounted in 1937 to \$584, while the value of net output per worker in manufacturing in the same year reached \$2,572.* In Britain the value of net output per worker in agriculture amounted in 1937-8 to £159, and in manufacturing industry in 1935 (the last year for which data are available) to £229 Even if we allow for some distortion of the data relating to agriculture owing to agricultural price intervention (subsidies, etc), it can be seen that the contribution of the American agricultural worker to the national output is substantially less than

* The value of net output is here used as an approximation to the contribution per head to the national output.

that of the American industrial worker. Such differences in the value of output per head in the different branches of the national economy do not reflect maldistribution of the working population, and do not indicate that the contribution of workers in one sector of the country is less important than in another sector. Taking the example of agriculture again, the gain for Britain is derived from the fact that instead of employing people in agriculture (with lower output), she is able to import her agricultural requirements and to employ people instead for producing manufactured goods for export.* The effect of this additional factor on real income comparisons is illustrated by the following simplified example. In the table below, under (*a*), the distribution of the working population is shown, excluding unemployed and the army. Under (*b*) output per head is shown, taking the value of output in U S. agriculture as equal to 1. For the other branches of the U S economy the figures express the ratios of the values of output per employed, to agriculture. For the U.K industries the income per head figures are based on the U.K - U.S. productivity ratios. Under (*c*) the income generated is based on the relative numbers employed in the different branches of the economy and their relative output per head.

	Agriculture	Manufacturing	Mining	Building	Public Utilities	Transport	Distribution	Finance	Services (Govt)	Total
				(*a*) Relative numbers employed (%)						
U K	4·7	36·1	4·5	6·6	2·7	6·6	15·0	2·2	21·6	100
U S	19·0	25·1	2·1	4·6	2·8	4·9	16·9	3·2	21·4	100
				(*b*) Output per head (index numbers)						
U K.	1·0	1·5	0·7	2·0	2·6	3·9	1·9	5·7	1·5	
U S	1·0	3·2	2·9	2·6	6·0	3·9	2·8	5·7	2·6	
				(*c*) Income generated						
U K	4·7	54·2	3·2	13·2	7·2	25·7	29·4	12·5	32·4	182·3
U S	19·0	80·3	6·1	12·0	16·8	19·2	47·3	18·3	55·5	274·5

Thus the ratio of total income generated per head between the two countries amounts to U K =100, U S =150.

* Thus the output of the British industrial worker can be exchanged through foreign trade for a larger amount of agricultural produce than the same worker could produce if employed in agriculture. This gain is not solely due to productivity differences, but also to the terms of trade.

† These notional ratios are based on figures computed by T Barna, 'The Productivity of Labour: Its Concept and Measurement', *Bulletin of the Oxford Institute of Statistics*, July 1946

(iii) *The effect of differences in the ratio of the working population to the total population, and the effect of unemployment*

The effect of another group of factors, namely the ratio of the working population to the total population, can also be approached quantitatively We have already allowed for differences in working hours by using per head comparisons of productivity

A comparison of the working population to the total population shows that (1) in the U S a lower proportion of the total population works, owing to a number of factors (a higher school-leaving age, a smaller number of women working in industry, etc), and (2) in the particular years of comparison a higher proportion of the working population was unemployed in the U.S. than in Britain *

The effect of these factors can be illustrated in the following manner· out of a total population of Great Britain of 45 7 millions, 19 75 millions or, if we make a rough allowance for domestic workers, perhaps 21·25 millions, constituted the working population In the U S., out of a total population of 131 7 millions, 49 4 millions or, including domestic servants, 52 0 millions, were working If we further assume that the per head income generated of those working in the different branches of the economy is 50% higher in the U.S than in the U K , we find that the differences in the ratios of the working population to total population reduce the income per head of the total population to 128 in the U S (U.K =100)

By excluding the unemployed from the working population this is reduced by 1·3 millions in Great Britain and by 6 9 millions in the U.S. (allowing for domestic servants unemployed). We then find that the income generated by the working population in employment before the war, if spread over the total population, would give a per head income of 100 in the U K and 124 in the U.S.

A further factor is due to differences in income from foreign investment, which was somewhat higher in Britain than in the United States, and in the pre-war years that are compared accounted for perhaps a further six points.†

The effect on real income comparisons of these different factors that have been noted can be summarized as follows

	U S as per cent of U K.
Estimated output per man-hour in manufacturing	273–292
Estimated output per worker in manufacturing	212–224
Estimated output per worker in all branches of the national economy	163–183
Allowing for distribution of working population coupled with lower relative output per worker in the different industries of the same country	150
Allowing for difference in the ratio of working population to total population	128
Allowing for higher U.S unemployment in the year of comparison	124
Allowing for slightly higher British income from foreign investments	118

* The difference in the proportion of those employed in the army is so small that it has been neglected. It appears that probably a higher proportion of old people were working in the U S

† See H W. Arndt, 'Productivity in Manufacturing and Real Income per head in Great Britain and the United States', *Oxford Economic Papers*, November 1947, p 78.

These figures do not lead to a complete reconciliation of the three types of real income comparisons, but they do suggest that there is no fundamental contradiction between the three types of approach: all three show a somewhat higher real income per head in the U.S. as compared with the U.K.

Our attempt at reconciling a higher U.S. productivity in manufacturing with the somewhat higher U.S. real income per head on the basis of productivity comparisons is necessarily approximate and indicates, at best, the order of magnitude of the effect of the different factors involved. It emphasizes, however, some facts which other real income comparisons neglect, e.g. that part of the U.S. real income is taken out in the form of greater leisure. It also indicates that for Britain by far the most important way of increasing the standard of living of the population is to increase productivity in manufacturing industry.

PART II

APPENDICES

SECTION I

International Productivity Comparisons in Individual Manufacturing Industries

SECTION I

INTERNATIONAL PRODUCTIVITY COMPARISONS IN INDIVIDUAL MANUFACTURING INDUSTRIES

APPENDIX 1

BLAST FURNACES

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The comparison of productivity of labour in this industry in the United States and the United Kingdom has been based on a comparison of the blast furnaces trade of the two countries as defined by the respective *Censuses*

Two factors will affect the comparison. In both countries firms produce either basic or acid pig iron, and in this case they usually form part of the integrated steel industry. Accordingly the validity of the data really depends on the extent to which the integrated firms succeeded in supplying separate reliable data on this sector. Alternatively forge and foundry pig iron is produced for use in foundries etc., and in this case it represents an industry that is different from that which produces, for example basic pig iron.

By treating all blast furnaces as a single industry and as an independent one, that is, as being independent of the main steel industry, some error is introduced, and in so far as the basic pig iron producing sector is more important in the U.S , the comparison will be somewhat biased in favour of the U.S.

II. COMPARATIVE DATA

Table 25. *Output, employment and productivity in the U.K and U.S. blast furnaces industries*

(*a*) *U K* 1924-37

Year	Output ('000 tons)	Operatives in the trade	Estimated no of operatives producing main products*	Actual hours of work	Estimated output per operative (tons)
1924	7,360 6	25,325	24,460	—	301
1930	6,251 6	18,083	17,000	—	367
1935	6,488 6	14,551	14,100	52 1	461
1937	8,371 0	18,170	18,260	48 0*	458

* October 1938

(*b*) *U S* 1925-39

Year	Capacity ('000 tons)	Output	Operatives in the trade	Estimated number of operatives producing main products†	Actual hours of work	Estimated output per operative (tons)
1925	53,435	36,496	29,188	28,400	—	1,285
1929	51,657	42,487	24,960	24,100	—	1,763
1935	49,870	21,164	15,178	14,500	34 9	1,460
1937	50,698	36,770	23,075	22,060	38 7	1,667
1939	49,753	31,518	19,537	18,480	35 5	1,705

† Adjusted by the ratio of the value of main products to the value of total output

Sources. For output and employment *Census of Production* and *Census of Manufactures.* For capacity in the U S *The Mineral Industry*, vol 49, 1940, ed G A Roush, New York and London, McGraw-Hill, 1941, p 319

For hours of work U K, *Ministry of Labour Gazette*, April 1937 and February 1944; U S, Bureau of Labor Statistics

Table 25 (c) *Productivity comparison*

	U K (1937)	U S (1937)
Estimated output per operative tons	458	1,667
index	100	364
Estimated output per man-hour index	100	452
Value of net output per operative	£373	$5,531
index*	100	300

* Converted at $4 94 to the £, the official rate of exchange

III. FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Differences in productivity in the blast furnaces trade have to be considered against the background of differences in the organization of the industry in the two countries The blast furnaces trade section of the iron and steel industry differs considerably in Britain and the U S

Integration and concentration both in the economic and in the technological sense have gone much further in the U S than in the U.K. An overwhelming proportion of both steel and pig iron on the one hand, and of the raw materials iron and coke, on the other hand, is produced in a few big units.

The scale of operation in the U S is much larger, and the fluctuations in the use of capacity are wider and deeper

(i) *Concentration*

In the U.S. in 1938 the three leading companies controlled 58% of the steel ingot capacity and 60% of pig iron capacity, and nine companies controlled 82% of both pig iron and steel ingot capacity.*

(ii) *Technological integration*

Together with concentration goes vertical integration. In the U S. this vertical integration is almost complete in the sense that steel producers own the blast furnaces and in turn they control financially or otherwise, for example by long-term contracts, almost the entire supply of iron ore and coke. In Britain before the war of 1939-45, the leading firms controlled probably only half of the total ore and coke supplies. What is, however, more important, technological integration was more advanced in the U S. than in Britain. Steel and consequently blast furnace production is concentrated in a few geographical districts, and a few powerful units produced a substantial proportion of output

In the case of iron ore (which is of very high iron content, the average being above 50%, and which all comes from home sources), although about 230 mines were in operation in the late thirties, 15 mines produced over half the total output

The situation is similar in the case of coke. The total requirements of the blast furnace trade in 'furnace coke' were produced in 1939 in about 40

* Temporary National Economic Committee, Monograph No 42, p 20, *The Basing Point Problem*, and *Hearings*, Part 26, p 13,903, Part 18, p 1,040.

units, and about one-third of all by-product coke, including everything other than furnace coke, was produced in 7 units The number of its in Britain producing an output of less than one-third of the American output, was produced in 1935 in 113 units.

In pig iron making about one-third of the total output is produced in 10 plants each with 500 or more operatives, and an additional one-third by another 18 plants each with 251 to 500 operatives Average output per plant in the U.S amounted to 389,000 tons in 1939 and 423,000 tons in 1937, this being in 1937 at a 72% rate of use of capacity, and in the U.K in 1935 average output per plant amounted to 135,000 tons.

Owing to higher labour productivity plant concentration in terms of operatives employed is rather less marked in the U.S. than in the U.K The average number of operatives per plant was 241 in the U.S. in 1939. The average number of employees per plant in the U K. in 1935 was 303.

(iii) *Size of furnaces in the U K and U S*

The productive capacity of the average American plant was appreciably larger than that of the average British plant There is also a decisive American advance—in fact one of the basic advances—in the average size of furnace capacity Average output per furnace in 1937 in Britain amounted to 68,500 tons, while in the U.S , with a working year of 280 days only, it amounted to 177,600 tons. The average number of days in which furnaces were in blast in the U K. is not known.

The concentration of furnace capacity is even more impressive. In the U.S 42% only of the total capacity was represented by furnaces with less than 400 tons daily capacity. the corresponding category in the U K , i e. under 2,000 tons weekly, represented 64 4% of the total capacity In the U S 78 2% of the total capacity was represented by furnaces with over 600 tons daily capacity, the corresponding category in the U K , i e over 3,000 tons weekly, represented only 8 7% of the total capacity

(iv) *Integration of steel making and pig iron making*

Another important factor is the close technological integration of steel making and pig iron making.

In the U S the proportion of basic pig iron produced is higher than in Britain In 1937 in the U S 68 3% of all pig iron and ferro-alloys made was basic pig iron, 15 2% 'Bessemer', 7 5% foundry pig iron, 6 2% malleable, 1·7% ferro-alloys, and 1 1% others. In the U.K. in the same year 55·1% was basic, 21 8% hematite, 19 4% foundry, 2 0% forge pig iron, and 1·7% others

In the U.S almost the total output of basic and Bessemer pig iron is used in 'other plants of the same company', 93% in 1937 and 96% in 1939 for basic pig iron, 96% and 98% respectively for Bessemer In the U.K. 84% of the basic pig iron and only 28% of hematite pig iron is used in 'own works', the rest is despatched. Also in the U S practically the total basic and Bessemer output used in other plants of the same company is used in the molten state, while in the U.K. of the above 84% of basic pig iron, 77% is used in

the molten state and another 7% cold, while in the case of hematite pig iron about half of the above 28% was used molten and another half cold, in 'own works'.

In the U S 89% of all pig iron is produced by integrated firms and 11% by non-integrated firms, of steel ingots 90% is produced by integrated firms and 10% by non-integrated firms, and of finished hot-rolled products 85% is produced by integrated firms, 9% by semi-integrated firms and 6% by non-integrated firms.

Almost all the pig iron coming to the open market is manufactured by the non-integrated so-called 'merchant' furnaces They are specialized in foundry, malleable and forge iron, which because of their low value and great bulk are distributed from these merchant furnaces to relatively local markets.

Otherwise geographical concentration is very close The location of industry is based largely on the location of coal, and there are a few big producing centres Of pig iron, for example, in 1937 32 0% was produced in Pennsylvania, 22·0 in Ohio, and 13 0% in Indiana, Michigan *

(v) *The scale of operation and use of capacity in the U K and U.S.*

The scale of operation in the American iron and steel industry is much above the British scale of operation Working at full capacity American industry could before the war produce five times as much pig iron and probably six times as much steel as this country could, although such a high use of capacity was achieved only during the last war Even in the peak year of 1929 82% only of the existing blast furnace capacity was used Fluctuations in the use of capacity were very marked throughout the inter-war period. In the depression it fell below 20% in 1932; it was 43% in 1935 and 72% in 1937. In the U.K. the lowest level was reached in 1932 at about 33%; it was probably 60% in 1935 and 70% in 1937 As much of the British capacity was obsolete, the use of practically exploitable capacity was probably higher.

(vi) *Degree of mechanization*

Available figures do not give adequate information on how much more mechanical equipment there is in the U.S. than in the U K nor on its quality.

Horse-power data are available only for the combined group of blast furnaces and steelworks, and have not been collected for Britain since the year 1930. As far as they go they do not suggest a quantitative deficiency of horse-power in the British industry, although they suggest a qualitative deficiency of equipment The increase in productivity in the U.S was due to the introduction of bigger furnaces, mechanical charging and auxiliary equipment, and more up-to-date machinery, and not necessarily to a greater quantity of machinery per operative or per unit of output.

(vii) *Summary*

To summarize the differences in industrial structure as they affect productivity, the following factors appear to have some importance.

* *Major Characteristics of the Iron and Steel Industry*, prepared by the U.S Department of Justice for the T.N E C. See *Hearings*, Part 18, p 10,401.

(*a*) The different structure of production; greater importance of basic pig iron. This is probably a small factor.
(*b*) Greater technological integration.
(*c*) The greater size of furnaces, a decisive factor.
(*d*) Greater scale of operation.
(*e*) Iron ore of higher ore content, and probably better prepared for use.
(*f*) Better quality coke
(*g*) Mechanization of auxiliary equipment and more up-to-date machinery.
(*h*) Fluctuations in the use of capacity This factor is more important in the U.S than in the U K It has also a more marked effect on productivity in the U.S. Thus in the pre-war period the highest productivity was realized in 1929, when the use of capacity was highest In 1925 and 1935 a low use of capacity also marks low productivity. On the whole it appears that in Britain, with many small plants and furnaces, the selective use of the most efficient units is a strong factor, while in the U.S the effect of economies achieved by a higher use of capacity is the more decisive factor in increasing productivity

APPENDIX 2
STEELWORKS

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

Steel making, although it is mostly carried out in integrated works, is not one industry but comprises a number of trades, and productivity comparisons will differ according to the delimitations that are made

The steel industries of two countries will probably have a different product structure in the sense that the proportions of light and heavy steel products having different labour contents, as well as the number of finishing processes applied to particular products, will differ. For example in the one industry re-rolling may have been carried one or two steps further than in the other. There will also be quality differences, even though the product may have the same name in the trade

For these reasons a comparison of the weight of output produced or the weight of steel ingot 'treated' will not give a satisfactory basis for comparison of output, and it is necessary to allow for differences in the balance of production as well as for the different types of finished products

II. COMPARATIVE DATA

On the basis of the above considerations the following comparative data were worked out by D. L Burn* for alternative groupings of the several steel trades.

Table 26. *Comparison of productivity of labour in the iron and steel industries, U.K , U S and Germany*

	U S. (1937)		U K (1937)		Germany (1936)	
	Output per operative					
	Long tons	Index	Long tons	Index	Long tons	Index
(a) Steelworks and rolling mills, including wire and wire products	73	166	44	100	—	—
(b) Blast furnaces, steelworks and rolling mills, including wire and wire products	70	171	41	100	49	120
(c) Blast furnaces, steelworks and rolling mills, excluding wire and wire products	80	174	46	100	65	141
Actual hours of work	37	—	46	—	46	—
U.S man-hour basis (a)	91	207	44	100	—	—
(b)	88	215	41	100	49	120
(c)	99	215	46	100	65	141

Notes. (i) The third comparison (c) appears to be the most satisfactory. Exclusion of wire and wire product is indicated by the fact that for Germany a great deal of wire made out of non-ferrous metal is included For the U S exclusion of wire has been made on a hypothetical basis

(ii) German figures for 1936 were compared with data for 1937 and the results were found to be broadly identical

(iii) Allowance has been made for differences in balance of production and between heavy and light products as well as different types of finished products

* The author wishes to record his thanks to Mr Burn for allowing him to publish the results of his investigations, a detailed account of which will be published by Mr. Burn

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 27 *Average size of establishment, concentration of employment and horse-power per 100 workers in the U K and U S. steel industries*

(*a*) *Average size of establishments* (number of operatives per establishment)

U K Trades	U K (1935)	U S (1937)	U S (1939)	U S Trades
Blast furnaces	303	265	241	Blast furnaces
Steelworks and rolling mills	386	1,653	1,458	Steelworks and rolling mills
Tinplate	321			
Wire	96	264	231	Wire drawn from purchased rod
		59	45	Wireworks not elsewhere classified
Chains, nails, screws, etc.	89	58	70	Nails, spikes, etc *
		122	92	Bolts, nuts, etc *
		94	74	Forgings*
Wrought iron and steel tubes	261	266	171	Wrought pipes*
		68	55	Springs, steel*
		166	131	Cold-rolled steel sheets and strips*
Average No of operatives	193	379	299	Average No of operatives

* Made in plants not operated in connection with rolling mills

(*b*) *Concentration of employment U K. 1935; U.S. 1939**

	Blast furnaces				Smelting and rolling of iron and steel				Smelting and rolling, including not integrated rolling industries and blast furnaces†			
Size of establishment (number employed)	No of establishm'ts		Proportion of employment		No of establishm'ts		Proportion of employment		No of establishm'ts		Proportion of employment	
	U K	U S	U K %	U S %	U K	U S	U K %	U S %	U K	U S	U K %	U S %
Up to 99 (100)	10	28	4	10	120	23	4	0 3	757	1,075	11	6
100-499 (101-500)	30	43	56	56	130	80	23	6 4	435	371	35	18
500-999 (501-1,000)	—	—	—	—	32	48	16	9 4	124	195	54	76
1,000 and over (1,001 and over)	8	10	40	34	36	102	57	83 9	—	—	—	—
Total	48	81	100	100	318	253	100	100	1,316	1,641	100	100

(*) For the U K all 'employees', for the U S 'operatives' U S size groups in brackets

(†) For industries included see Table 27

Table 27. (*c*) *Horse-power per* 100 *workers*†

U.K. Trades	U K (1930)	U S (1939)	U S Trades
Blast furnaces Steelworks and rolling mills	1,401	2,459	Blast furnaces Steelworks
Tinplate	458		
Wire	481	824	Wire drawn
		261	Wireworks
Chain, etc	203	408	Nails*
		579	Bolts*
		937	Forgings*
Wrought iron	482	955	Wrought pipes
		557	Springs, steel*
		1,782	Cold-rolled steel sheets*

* Made in plants not operated in connection with rolling mills

† For U K 'power in use' as computed by the U K. *Census*, for U S 'power installed' as computed by the U S *Census*

APPENDIX 3
IRON FOUNDRIES

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The comparison is affected by the following factors

(i) The British *Census* group comprises all firms engaged in the manufacture of iron and steel castings, except direct steel castings in rolling mills, thus the British trade covers a wide range of finished products, such as stoves, grates, cooking and washing boilers, etc. made out of cast iron

(ii) The U S *Census* treats iron foundries and steel foundries separately; moreover the manufacture of any finished products, such as those mentioned above, is treated as a separate industry The following trades, forming the U S 'iron and steel foundry products' trade, were assumed to be comparable with the corresponding British trade in the sense that they all start at the pig iron stage.

U S. cast iron pipe and fittings —U K. cast iron and steel pipes and fittings

U S malleable iron castings —U K. malleable iron castings

U.S. Gray iron and semi-steel castings —U.K. engineering castings
U.S. Steel castings (not made in rolling mills) —U.K other and unclassified castings

The first and second of these groups appear fairly comparable, whereas in the third group the results will be influenced by treating the two U S. groups as one, and also by the fact that in the corresponding British groups the production process has been taken perhaps one stage further than in the U.S. groups. The comparison is crude as it is based on physical weight only.

II. COMPARATIVE DATA

Table 28 *Output, employment and productivity in the U.K and U S. cast-iron pipes and fittings industries*

	U K (1935)	U S (1935)	U S (1937)	U S (1939)
Output ('000 tons)	671 7	663 3	980 7	1,129 6
Employees in trade	19,714	14,574	18,793	17,709
Operatives in trade	—	13,543	17,580	16,488
Estimated number of employees producing output	19,700	13,570	18,000	18,600
Estimated number of operatives producing output	17,800	12,600	16,840	17,320
Actual weekly hours worked	48 2*	31 0	37 8	36 4
Output per employee (tons)	34 1	48 9	54 6	60 7
Output per operative (tons)	37 7	52 6	58 4	65 2
Output per operative (index)	100	140	155	173
The value of net output per operative	£218	$1,703	$2,029	$2,248

* Iron foundries in general

Table 29 *Output, employment and productivity in the U K and U S malleable castings industries*

	U K (1935)	U S (1937)	U S (1939)
Output ('000 tons)	49 3	518	381
Employees in trade	7,835	—	19,869
Operatives in trade	—	23,713	18,041
Estimated number of employees producing output	6,700	—	21,900
Estimated number of operatives producing output	6,060	27,200	19,900
Output per employee (tons)	7 4	—	17 4
Output per operative (tons)	8 1	19 0	19 2
Output per operative (index)	100	234	236
The value of net output per operative	£196	$1,919	$1,968

Table 30 *Output, employment and productivity in other iron foundry trades (excluding stoves, grates, boilers, cisterns, baths, etc) in the U K and U.S.*

(a) Output and employment

	U.K (1935)*	U S (1935)†	U S (1937)†	U S (1939)‡
Output ('000 tons)	949 0	2,980	4,782	2,694
Employees in trade	49,320	97,513	129,070	98,647
Operatives in trade	—	89,894	120,024	88,516
Estimated number of employees producing output	50,000	101,120	143,800	85,500
Estimated number of operatives producing output	44,600	93,310	134,000	76,750
Hours of work	—	—	—	37·1
(b) Productivity				
Output per employee (tons)	19 0	(29 5)	(33 3)	31 5
Output per operative (tons)	21 0	(31 9)	(35 7)	35 1
Output per operative (index)	100	(152)	(170)	167
The value of net output per operative	£208	$1,781	$2,129	$2,496

* Includes engineering castings, and all other castings classified and unclassified

† Includes foundry products (gray iron and malleable iron) made in this and other trades, but excludes 'other products'

‡ Includes 'gray iron and semi-steel castings' produced in this industry and 'steel castings produced in this industry Excludes cast iron and steel made in other industries and excludes 'other products'.

Table 31. *Output, employment and productivity in the whole U K and U S. foundry industries* (trades specified in Tables 28–30)

	U K (1935)	U S (1935)	U S (1937)	U S (1939)
Weighted output per operative*	100	150	167	177
Weighted output per man-hour	100	—	—	230
Average value of net output per operative	£209	$1,772	$2,118	$2,400

* Weighted by U K and U S employment.

Table 32. *Average size of establishment, concentration of employment and horse-power per operative in the U K. and U S iron foundry industries*

(a) Average size of establishment

	Average no of operatives	No of establishments
U K (1935) Iron Foundries (1)-(5), of which	117	847
(1) Iron and steel pipes	244	73
(2) Malleable castings	127	56
(3) Other iron castings	74	605
(4) Cast-iron stoves	276	91
(5) Cisterns, baths, etc	208	22
U S (1939) Iron Foundries (1)-(4), of which	83	1,482
(1) Pipes and fittings	222	74
(2) Malleable castings	217	83
(3) Gray iron and semi-steel castings	50	1,161
(4) Steel castings	183	164
(5) Stoves, ranges, etc	93	449
(6) Plumbers' supplies	95	259

*(b) Concentration of employment**

Size of establishment (number employed)	Number of establishments					
	U K (1935)	U S (1939)				
	All foundries	All foundries	Pipes	Malleable castings	Gray iron	Steel castings
Up to 99 (100)	577	1,139	23	19	1,023	74
100-999 (101-1,000)	259	340	51	64	137	88
1,000 (1,001) and over	11	3	—	—	1	2
Total	847	1,482	74	83	1,161	164
	% Proportion of employment					
Up to 99 (100)	21	29	7	6	51	12
100-999 (101-1,000)	62	71†	93	94	49‡	88§
1,000 (1,001) and over	17	—	—	—	—	—
Total	100%	100%	100%	100%	100%	100%

* For the U K all 'employees', for the U S 'operatives' U S size groups in brackets
† Including three establishments with 1,001 and more employed
‡ Including one establishment with 1,001 and more employed
§ Including two establishments with 1,001 and more employed
Note It should be noted that the U K figures include stoves, grates, etc, and cisterns, baths, etc, in both sections the average establishment is bigger than for the industry as a whole and the total number of establishments is small

(c) Horse-power per operative

		H P per operative*
U S (1939)	Gray iron	467
	Malleable iron	474
	Steel castings	900
	Pipes	405
U K (1930)	Iron foundries	176

* For the U K 'power in use' as computed in the U K *Census*; for U.S. 'power installed' as computed in the U.S *Census*.

APPENDIX 4

MACHINERY

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

Owing to the extremely complex structure of the engineering industries in both countries, as well as to the non-comparable character of the quantitative data on output which are given in tons for the U K. and in numbers of machines produced for the U.S , the comparison has been made on the basis of the value of net output per operative. The value of net output per operative is expressed in £'s and $'s respectively and $'s are then converted into £'s at the official rate of exchange. In so far as the rate of exchange in terms of engineering products differs from the general rate of exchange, this comparison is arbitrary.

II. COMPARATIVE DATA

Table 33 *Comparison of net output per operative in the U K. and U S machinery industries*

(*a*) *U.K* 1935

	Value of net output (£'000)	No of operatives	Net output per operative (£)
Mechanical engineering	98,027	360,052	272
Electrical machinery	18,615	64,600*	288
Total	116,642	424,652	275

* Assuming that the ratio of operatives to all employees is the same in all sub-divisions of 'electrical engineering'.

(*b*) *U S.* 1937, 1939

	Value of net output ($'000,000)		No of operatives		Net output per operative	
	1937	1939	1937	1939	1937	1939
Machinery (except electrical)	2,332	1,969	643,522	522,980	3,624	3,765
Electrical equipment for industrial use	460	374	122,196	95,130	3,764	3,931
Total	2,792	2,343	765,718	618,110	3,646	3,790
Converted into £'s at the official rate of exchange					£737	£854
Index (U K =100)					268	310

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 34. *Average size of establishment, concentration of employment and horse-power per operative in the U.K. and U.S. machinery industries*

(a) *Average size of establishment*

Electrical Machinery	U K	(1935)	399 operatives
	U S	(1939)	131 ,,
		(1937)	209 ,,
Mechanical Engineering	U K	(1935)	115 ,,
Machinery	U S	(1939)	55 ,,
		(1937)	77 ,,

(b) *Concentration of employment**

Size of establishment (number employed)	No of establishments				% Proportion of employment			
	Electrical machinery		Mechanical engineering†		Electrical machinery		Mechanical engineering†	
	U K	U S.	U K	U S	U K	U S	U K	U S.
					%	%	%	%
Up to 99 (up to 100)	83	564	2,295	8,555	4	12	19	26
100-499 (101-500)	45	124	661	789	12	25	33	34
500-999 (501-1,000)	14	23	111	91	12	18	18	13
1,000 (1,001) and over	20	16	66	71	72	45	30	27
Total	162	727	3,133	9,506	100	100	100	100

* For the U K all 'employees', for the U S 'operatives' U S size groups in brackets
† For U S , Machinery

(c) *Horse-power per* 100 *operatives**

Total electrical engineering	U K	(1930)	157 h p
Electrical machinery	U S	(1939)	397 ,,
Mechanical engineering	U K	(1930)	245 ,,
Machinery	U S	(1939)	499 ,,

* For the U K 'power in use' as computed in the U K *Census*, for the U S 'power installed' as computed in the U S *Census*

APPENDIX 5
CEMENT

I. SPECIFIC FACTORS AFFECTING PRODUCTIVITY COMPARISONS

The cement industries as defined by the two *Censuses* are compared without making allowances for the quality of the cement produced In both countries the overwhelming proportion of the output is Portland cement. The differing ratios of other cement to Portland cement do not affect the comparisons A few firms produce other products, although they are classified in the cement industry; for example, gypsum in the U.K. The effect of this factor is small and is dealt with by adjusting the output figures according to the ratio of the value of the main products produced to the total output

II. COMPARATIVE DATA

Table 35. *Output and employment in the U K and U S cement industries*

(a) U K.

Year	Capacity ('000 tons)	Output ('000 tons)	Employment, number of operatives in the trade	Estimated number of operatives producing output	Output per operative (tons)	Actual average (weekly hours)
1907	3,700	2,886	13,860*	12,770*	226*	—
1924	4,250	3,240	12,450*	10,840*	249*	49 9
1930			12,030*	11,360*	445*	
1930	—	5,056	9,755	9,300	545	—
1935	7,000 (approx)	5,947	8,278	7,500	793	51 8
1938	8,750	7,715	—	9,300	837	49 9

* Includes quarries

Sources.

For output and employment *Censuses of Production*

For capacity See Rostas, *Productivity, Prices and Distribution in Selected British Industries*, N I.E.S.R Occasional Paper XI, Cambridge University Press, 1948, p 79

For hours of work *Ministry of Labour Gazette*, July 1926, February 1937 and February 1944.

For 1938, Output *Statistical Yearbook of the League of Nations*, 1938-9, Geneva, 1939, p 131, Employment Estimated on the basis of Social Insurance statistics

(b) U S.

Year	Rated capacity ('000 tons)	Output ('000 tons)	Employment, number of operatives in the trade	Estimated number of operatives producing output	Output per operative (tons)	Actual average (weekly hours)
1909	—	11,195	26,775	22,700	493	—
1923	27,200	23,298	35,091	34,900	667	—
1924	29,400	—	—	—	—	—
1925	32,500	27,428	38,437	37,900	724	—
1927	38,100	29,433	36,322	36,000	818	—
1929	43,500	29,017	33,368	31,900	910	—
1930	45,300	—	—	—	—	—
1935	44,000	13,051	20,698	20,200	646	33·9
1937	42,800	19,821	26,426	25,200	786	38 8
1938	42,900	—	—	—	—	—
1939	—	20,933	23,801	22,700	922	38 2

Sources

For output and employment: *Censuses of Manufactures.*

For capacity· Works Progress Administration National Research Project *Mechanization in the Cement Industry*, by G. Perazich, S. T Wool and H. Schimmel, Report M-3, December 1939, Appendix Table A1.

For hours of work: Bureau of Labor Statistics

Table 36 *Productivity comparisons in the U.K and U S cement industries*

	U K		U S		
	1935	1938	1935	1937	1939
Estimated output per operative (tons)	793	838	646	786	922
(index)	100	—	81	99	116
(index)	—	100	—	94	110
Estimated output per man-hour (index)	100	—	124	132	157
(index)	—	100	—	121	144
The value of net output per operative	£697	—	$3,736	$4,284	$5,213

III. FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 37 *Average size of establishment, concentration of employment and horse-power per operative in the U K and U S cement industries*

(*a*) *Average size of establishment*

U K (1935) 127 operatives per establishment
U S (1935) 135 ,, ,, ,,
U S (1937) 167 ,, ,, ,,
U S (1939) 149 ,, ,, ,,

(*b*) *Concentration of employment**

Size of establishment (number employed)	Number of establishments		Proportion of employment	
	U K (1935)	U S (1939)	U K (1935)	U S (1939)
			%	%
Up to 99 (100)	31	50	15	13
100-499 (101-500)	29	108	53	87†
500 and over (501 and over)	5	2	32	—
Total	65	160	100	100

* For the U K all 'employees', for the U S. 'operatives' U S size groups in brackets
† 101 and over Including two establishments employing over 500 wage-earners

(*c*) *Horse-power per* 100 *wage-earners**

U K (1924) 752 h p	U S (1909) 1,390 h p
(1930) 1,505 ,,	(1929) 3,548 ,,
	(1939) 5,173 ,,

* For U K 'power in use' as computed in the U K *Census*, for U S 'power installed' as computed in the U S *Census*

(1) *The structure of the American cement trade**

This is very similar to that of the British industry. In 1931, by which year the present capacity of the American industry was already in existence, the *five largest companies* (operating 47 plants) *controlled* 40% *of the output* and were leaders of the industry, generally followed by smaller companies in matters of policy and price The largest firm in the industry, the Universal-

* For a description of the structure of the British industry see Rostas, *Productivity, Prices and Distribution*, op cit, pp 76 ff

Atlas Company, controlled about 17% of the domestic shipment of cement.* In America, just as in Britain, keen price warfare, together with cyclical fluctuations in demand and consequential excess capacity, promoted mergers and increased the powers of the bigger units. This facilitated unanimity in price policy by reducing the number of price policies to be brought into harmony and eliminated recalcitrant producers. Resistance has, however, been encountered. The Federal Trade Commission reported the application of various forms of pressure to firms refusing to adopt the pricing structure conventional in the industry. *The common price policy* of the trade was founded on the use of a number of basing points, with all the consequential price discriminations involved.†

The size distribution of establishments as ascertained from the *Censuses* shows the following: the thirteen largest establishments of over 250 wage-earners in the U.S. employed 21·1% of the total labour force, in the U.K. the thirteen largest establishments of over 200 employees employed 43·7% of the total.

The bulk of American employment was in establishments employing 100-250 workers, 65·7% of the total, while the nearest corresponding size group in Britain (of 100-200 persons), employed another 41·7% of all personnel. Thus the British plants seem to be somewhat bigger than the American plants, although the American data might be influenced by low use of capacity. Also British data include salaried personnel.

	Average size of establishments employing over 100 persons
U.S. (1939)	188 operatives
U.K. (1935)	255 persons

(ii) *Output and capacity*

There has been a spectacular development in the American cement trade, similar to the increase in the British trade, over the last forty years. Since the beginning of the century the capacity of the trade has increased four- to five-fold; since 1909 it has nearly trebled. Output has also gone up by leaps and bounds, even if not altogether to the same extent. From 1909 to its peak in 1928 it increased nearly threefold. The horse-power equipment of the trade has increased ninefold since 1904 and almost fourfold since 1909.

There are, however, two important differences as compared with the British development. In the U.S. the expansion of capacity came to an end in 1930, while in Britain it went on throughout the thirties. Also in the U.S. the creation of new capacity outstripped sales, so that there has been a considerable excess capacity throughout the last thirty years. The use of capacity amounted, for example, to 83·5% in 1925; it declined to 65·9% in 1929 and 59·7% in 1930; i.e. *increased output was accompanied by increased excess capacity*. Throughout the thirties the use of capacity was extremely low, in 1935 little more than 30%; in 1937 and 1939 it was still less than 50%.

* Federal Trade Commission, *Cement Industry*, 1933. Quoted by A. R. Burns in *The Decline of Competition*, New York and London, McGraw-Hill, 1936.

† Burns, op. cit. pp. 317-22.

British expansion of capacity developed parallel with increased sales and use of capacity was fairly constantly about three-quarters to four-fifths of the existing capacity

(iii) *Changes in U S labour productivity*

Productivity per operative has increased considerably in the American trade and since 1909 it has nearly doubled. This increase was less spectacular than the increase in Britain, for various reasons It was less so partly because American industry was already more heavily mechanized at the beginning of the century Moreover, productivity per man was fairly closely correlated with use of capacity This is the reason of low productivity, for example in 1930, and for the great fluctuations in productivity throughout the inter-war period.

It is more relevant however to follow changes in output per man-hour, instead of changes in output per operative Here we find a continuous increase in labour productivity without a break From 1919 to 1940 it amounts to some 150%. A relatively steady upward trend throughout the twenties was interrupted by minor fluctuations during the depressed thirties, but after 1938 the general upward movement was resumed In Britain the main increase took place between 1924 and 1938.

The U S Bureau of Labor Statistics in analysing these changes* points out that this increase in productivity took place without major changes in basic manufacturing techniques A number of minor technical improvements, however, were introduced The increase in productivity appears to have been occasioned primarily by the construction of new plants and the modernization of a considerable number of older ones An increase in average plant capacity was also a factor, since unit labour requirements tend to be lower in large than in small plants.

The main factors affecting productivity increases in the U S according to the Bureau of Labor Statistics' study can be summarized as follows·

(*a*) *Improvements in quality* The cementing capacity and the range of applicability of cement greatly increased in the U S This improvement necessitated more labour, especially in the grinding stage.

Another factor was the production of special cements, such as high early strength, quick set, water proof, colour, low heat cements, etc. The labour requirements per unit for these special cements are higher, and their share in total output, though still very small, is increasing. It was 2% in 1927-8 and 8% in 1934-5.

(*b*) *Technical progress* The installation of large-capacity equipment was a significant factor in increasing productivity, since about the same amount of operating and maintenance labour is required for large as for small machine units

The reductions in labour requirements as from 1919 to 1934 were ascer-

* 'Productivity in the Portland Cement Industry', prepared by A W. Frazer and L A. Epstein under the direction of D Evans, *Monthly Labor Review*, October 1941, pp 862 ff.

tained by a sample enquiry of the Works Progress Administration.* It showed the following results:

	Per cent of reduction in labour requirements per unit of finished cement, 1919-34
All departments	51 7
Quarrying	57 7
Processing	49 2
Raw grinding and crushing	54 4
Burning	19 3
Finish grinding	56 3
Fuel preparation	59 5
Power	52 0
Maintenance and repair	62 2
Mill overhead (supervision, etc.)	28 3
Shipping (bagging, etc)	49 6

As can be seen, the reduction in all cases was substantial. It was due to a number of different minor technical improvements In the case of burning, the smaller decrease is compensated by fuel economy Instead of coal, increased use was made of oil and natural gas.

A further technical factor was the introduction of the so-called *wet process* for preparation of the raw materials prior to calcination, which is used in almost half of all plants. There is however no conclusive evidence that this method has relative advantages in terms of productivity.

The size of plant is a more decisive and measurable factor Large plants, as the Bureau of Labor Statistics points out, appear to have managerial as well as technical advantages

The effect of size and productivity is illustrated by the following data.

Table 38. *Average number of man-hours required to produce* 100 *barrels of cement in* 88 *sample mills in* 1934 *in the U S* (*Bureau of Labor Statistics sample*)

Capacity	No of plants	Average number of man-hours per 100 barrels
All plants	88	47 [illegible]
3,000,000 barrels and over	4	40 0
2,500,000 to 2,999,999 barrels	6	47 5
2,000,000 ,, 2,499,999 ,,	10	49 3
1,500,000 ,, 1,999,999 ,,	29	48 5
1,000,000 ,, 1,499,999 ,,	29	56 0
Under 1,000,000 barrels	10	64 5

The effect of size of plant on labour productivity in Britain shows the same tendency, i.e. productivity increases with size.

(*c*) *Labour productivity and use of capacity*. Productivity in individual plants is directly related to the rate of operations. As the Bureau of Labor Statistics reports point out, although large quantities of clinker may be stored during

* *Mechanization in the Cement Industry*, op. cit. (Table 11, p 31), based on H. E. Hilts, 'Shall the State Own and Operate its Own Portland Cement Plant?' *Public Roads*, Vol 3, No 33, January 1921· coverage of sample, 40 6%, and on B H. Topkis, 'Labor Requirements in Cement Production', *Monthly Labor Review*, March 1936. coverage of sample, 74·8%.

the winter and early spring months in anticipation of heavy demands for finished cement during summer and autumn, the production of a plant is generally geared to the output of the kilns The rate of operation of a single kiln cannot be varied If a plant has more than one kiln, its rate of operation may be varied by the utilization of different numbers of kilns not all of which need have the same capacity.

For a number of sample establishments the following variations were ascertained in man-hour requirements according to the scale of operations·*

Practicably obtainable capacity utilized	Man-hours required per unit of output
%	
100	100
80	108 6
60	120 8
40	140 4
20	181 4

For the industry as a whole the effect of labour saving in the case of the use of full capacity is counterbalanced by the 'selective' operation of more efficient plants This was particularly important in American industry in the thirties

The following table illustrates the interrelations of use of capacity to labour productivity

Table 39. *Actual and estimated labour requirements at full capacity in the U S Portland cement industry*, 1919-40†

Year	Percentage of practicably obtainable capacity utilized	Man-hours per 100 barrels finished cement at	
		Actual rate of operation	Full capacity (estimated)
	%		
1919	67	98 5	84 9
1924	100	73 6	73 6
1930	70	56 0	49 0
1935	34	51 1	34 3
1937	54	48 3	38 5
1938	48	45 7	34 8
1939	56	42 2	34 1
1940	60	39 1	32 4

* Works Progress Administration National Research Project, op cit , p 23

† Works Progress Administration National Research Project, op cit , Table 8, p 24, for 1919-38 Extended by the Bureau of Labor Statistics for 1939 and 1940 See *Monthly Labor Review*, October 1941, p 873

APPENDIX 6

BRICKS

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The comparison relates to the building brick industries of the two countries (i e. it excludes fire-bricks, etc)

The 'building brick' trade is a sub-division of the brick trade in the United Kingdom *Census*; the United States *Census* of 1939 distinguishes the 'brick and hollow structural tile' trade as a sub-group, whereas for previous years it was included in the 'clay products other than pottery' sub-group Data for these years have been based on two studies of the Works Progress Administration National Research Project.*

II. BASIC DATA AND COMPARISONS

Tables 40-47 give the basic data on output and employment, and show the comparisons of productivity of labour

Table 40 *Process in brick manufacture in the U K and U S.*

(a) U K

Manufacturing process	Percentage of total national output (clay and shale bricks only)	
	1938	1941
Hand made	2 06	0 47
Stock	3 31	1 54
Wire-cut	30 62	29 66
Stiff-plastic	31 01	35 00
Semi-dry pressed	33 00	33 33
Total	100	100

(b) U.S (1925)

Manufacturing process	Percentage of total national output
Stiff-mud process*	50
Soft-mud process	40
Others	10
Total	100

* Corresponds to British wire-cut method

Sources U K.: *Third Report of the Committee on the Brick Industry*, 1943, p 23
U S · Works Progress Administration, National Research Project *Studies*. Van Tassel and Bluestone, op. cit , p. 2

* M. E West *Brick and Tile*, February 1939 A J. Van Tassel and D. W Bluestone· *Mechanization in the Brick Industry*, June 1939

Table 41. *Output and employment in the U K. brick industry*, 1907–35

	Unit	1907	1912	1924 (a) (As shown in 1924 *Census* Reports)	1924 (b) (As shown in 1935 *Census* Reports)	1930	1933	1934	1935
(1) Value of gross output of bricks									
Building bricks	£'000	6,373	5,172	11,636	11,330	11,661	12,918	14,912	15,909
Firebricks				2,208	—	—	—	—	—
Silica bricks				805	—	—	—	—	—
(2) Quantity of output of bricks									
Building bricks	Millions	4,794 7	3,720 5	4,066 1	3,960 9	4,751 1	5,873 8	6,732 8	7,310 3
Firebricks				1,079 3*	—	—	—	—	—
Silica bricks				228 6*					
(3) Average number of persons employed in the bricks and fireclay goods trade	Number	69,592	58,864	70,324	68,474	75,629	75,177	84,466	92,074
(4) Average number of operatives employed in the bricks and fireclay goods trade	Number	65,866	55,557	65,508	63,957	70,880	70,122	79,033	86,442
(5) Estimated employees producing bricks (including firebricks)†	Number	53,308	41,850	48,817	—	—	—	—	—
(6) Estimated operatives producing bricks (including firebricks)†	Number	50,450	39,500	45,463	—	—	—	—	—
(7) Estimated employees producing building bricks†	Number	—	—	—	37,460	40,700	43,900	49,100	52,400
(8) Estimated operatives producing building bricks†	Number	—	—	—	35,000	38,100	41,000	45,900	49,200
(9) Average actual hours of work per week	Hours	55‡	—	47 4	—	—	—	—	49 1

* '000 tons

† Owing to the fact that the bricks and fireclay industry has other products as well as bricks, the employment data corresponding to the bricks (or building bricks) output have to be adjusted according to the ratio of the value of bricks (or building bricks) output to the value of output of the whole bricks and fireclay industry

‡ In building materials trades in general

Source Censuse's of Production, for hours of work Ministry of Labour statistics

Table 42 *Product structure in the brick industries of the U K and U S*

(i) *U K* (ii) *U S.*

Clay and shale bricks	1938 % (physical output)	Bricks	1935 % (physical output)
Common	85 2	Common	76 5
Facing	12 2	Facing	20 0
Engineering	2 6	Vitrified	3 5
Total	100	Total	100

Sources U K *First Report of the Committee on the Brick Industry*, 1942, p 7
U S Works Progress Administration, National Research Project *Studies*, West, op cit., Table A-13, p 169

Table 43 *Output, employment and productivity in the U S brick industry*

Year	Production (millions of common bricks equivalent)	Average number of wage-earners	Use of capacity	Output per wage-earner ('000 bricks)	Man-hours per 1,000 common bricks
1869	3,012	30,347	—	99	27 4
1879	4,505	40,592	—	111	24 5
1889	10,009	65,020	100	154	17 3
1899	10,603	65,822	85	161	16 4
1909	15,738	76,298	100	206	12 7
1914	13,098	63,189	84	207	12 4
1919	9,155	46,549	59	197	12 6
1921	8,752	41,361	57	212	11 5
1923	14,275	58,981	93	242	10 0
1925	15,388	58,050	100	265	9 0
1927	14,708	54,721	96	269	8 7
1929	12,581	47,771	82	263	8 8
1933	2,035	11,165	13	182	9 2
1935	3,426	17,466	23	196	9 7

Sources Works Progress Administration, National Research Project *Studies*, West, op cit, Tables 4 and 8
Works Progress Administration, National Research Project *Studies*, Van Tassel and Bluestone, op cit

Table 44 *Comparison of productivity of labour in the U K. and U S. brick industries*

Year	Output in common bricks equivalent (million)	Corresponding employment	Hours of work	Output per operative ('000 bricks)	Man-hours needed per 1,000 common bricks
U S					
1925	15,388	58,050	—	265	9 0
1935	3,426	17,466	37 2	196	9 7
U K.					
1935	7,975	49,200	49 1	162	15·4

Comparisons.

Output per operative	U K	(1935)	100
	U S	(1935)	121
	U S	(1925)	164
Output per man-hour	U K	(1935)	100
	U S	(1935)	159
	U S	(1925)	171

Note Different kinds of bricks have been converted into common bricks on the basis of their relative values For the U K it has been assumed that the product structure was the same for 1935 as in 1938, for which year data are available on the amount of facing bricks, etc produced

For calculating man-hours needed per 1,000 bricks, 51 working weeks have been assumed

The U S data are based on the two publications of the Works Progress Administration's National Research Project published in 1939 (West, op cit; Van Tassel and Bluestone, op. cit)

Table 45 *Changes in productivity in the U K brick industry*

(*a*) *Bricks (including firebricks)* 1907-1924

	Unit	1907	1912	1924
Output of bricks per employee	1,000	89 9	88 9	—
	Index	100	99	100*
Output of bricks per operative	1,000	95 0	94 2	—
	Index	100	99	100*
Output of bricks per operative man-hours	Index	100	—	116

* Based on the text of the 1924 *Census* report, saying that it appears reasonable to conclude that there was 'not much change in the production either of firebricks or of building bricks in 1924 compared with 1907' (p 198 of final report)

(*b*) *Building bricks* 1924-1935

	Unit	1924	1930	1933	1934	1935
Output of building bricks per employee	1,000	106	177	134	137	140
	Index	100	110	127	130	132
Output of building bricks per operative	1,000	113	125	143	147	149
	Index	100	110	127	130	131
Output of building bricks per operative man-hours	Index	100	—	—	—	127

(*c*) *Approximate changes* 1907-1935

		1907	1935
Output per operative	Index	100	131
Output per man-hour	Index	100	147

Table 46 *Long-term changes in productivity of labour in the U.K. and U S brick industries*

Year	Output per operative		Output per man-hour	
	U K	U S	U K	U S
1907	100		100	
1909		100		100
1924	100		116	
1925		129		141
1935	131	95	147	131

III. FACTORS AFFECTING PRODUCTIVITY COMPARISONS

(1) *The structure and organization of the building-brick industry in the U K and U S*

The structure and organization of the building brick industry is determined both in the U.K and in the U S. by the fact that the basic raw material of brick making (clay and brick earth) can be found in practically all parts of of the country; and secondly, that brick is a bulky commodity, and transport costs account for a substantial proportion of total sales value. In consequence, the brick industry is strongly localized and the total brick supply is provided by hundreds of firms. Owing to heavy transport costs, there is no national market, but a number of local markets The average brick works is small, its size being mainly determined by the size of the market.

There is one exception to this general picture—a very important exception—the so-called Fletton group of producers, responsible for about one-third of the pre-war brick supply of the U.K , this development has no counterpart in the U S. The size of the average works in the Fletton group is larger. The Fletton group has its works in the vicinities of Bedford and Peterborough, where the raw material has a favourable content of carbonaceous matter. This permits full burning of bricks with substantially less fuel per 1,000 bricks. In recent years the industry has obtained adequate financial resources and has developed a high degree of mechanization to which the raw material lends itself; consequently the amount of labour used per 1,000 bricks is also lower than for other sections of the industry, and is approximately on the U S level. Both these factors reduce the costs of production. The third favourable factor is that the Fletton brick weighs less than the average common brick, and that fact, combined with the quantities involved, has permitted advantageous transport terms and consequently widespread distribution. In the years immediately before the outbreak of the war Fletton producers were able to compete with local producers in many parts of the country and proceeded to develop their marketing and distribution on a national basis. This expansion was interrupted by the war, owing to the limitation of permissible transport radius

There is a third group of producers—apart from non-Fletton and Fletton—the so-called sand-lime group. Their production is also based on mass-production methods combined with an economic fuel consumption and consequently low cost of production. While the potentialities of the group are great, as first-class sand can be found in many parts of the country, their importance just before the outbreak of the war was relatively small.

In 1935 when the building brick industry, broadly speaking, reached its peak-time production, 7,310·3 million bricks (or 7,975 millions in equivalent of common bricks) were produced by about 49,200 operatives in 1,022 establishments. Of this output about one-third was produced by the Fletton group, and 120 millions by the sand-lime group. The average size of establishment in the building brick industry as a whole was 48 operatives. Average annual

output per establishment was little more than 7 million bricks, while in the Fletton group it was perhaps more than ten times as much.

The *Census of Production* indicates a continuous upward trend in the development of the brick industry. Unfortunately the pre-last-war *Censuses* did not distinguish between the building brick and the firebrick industries; thus the development of the building brick industry can be reliably traced only in the 1924-35 period. Assuming that there was no substantial change in the firebrick and silica industries in the 1907-24 period, the building brick industry showed some expansion in the same period. (See Table 40.) But this expansion was relatively small as compared with the 1924-35 period when brick output—increasing year by year—nearly doubled and employment increased by perhaps 50%. The increase was even greater in the Fletton group, where output was estimated at 450 millions in 1913 and at about the same level in 1921, while in 1938 it can be put at 2,600 millions. There was an increase in the number of establishments in the brick industry as a whole from 875 in 1930 to 1,022 in 1935.

It is interesting to contrast this upward trend in the British brick industry with the entirely different development of the U.S. brick industry. There the peak production had been achieved by 1925 with an output of 15,400 million common brick equivalent and 58,000 operatives, when the use of capacity was 100%. This level of production was never recovered. The lowest level of output was reached in 1933 in the slump when the use of capacity was 13%, even in 1935 the use of capacity was only 23%. It appears that the substitution of bricks by other building materials (steel, concrete, and hollow tile, etc.) has been definitely more important in the U.S. than in the U.K. It follows from the use of other building material that a somewhat higher proportion of all bricks used in the U.S. are facing bricks, about one-fifth, while the proportion is about one-eighth of all bricks used in normal years in the U.K.

Processes of brick-making are not quite comparable in the two countries. The wire-cut method is used to a greater extent in the U.S. than here, on the other hand, available statistics do not indicate any hand-made bricks. The semi-dry process does not appear to be used.

As in the U.K., the brick industry in the U.S. is a strongly localized industry, and an industry in which small-scale operations prevail. In 1939, 800 establishments were employed in producing 4,200 million bricks. Thus the average size of establishment is smaller in the U.S. than in the U.K.—in the U.S. 38 operatives in 1925, 24 in 1935, and 36 in 1939, while in Britain there were 48 operatives per establishment in 1935. In the neighbourhood of big cities (i.e. big markets) the size of establishments is slightly higher.

Concentration of establishment is also higher in the British brick industry as compared with the U.S. industry, as can be seen from the following figures in Table 47 (p. 120).

There were in 1935 in the British building brick industry 123 business units employing 500 persons or more.* The three largest units employed

* A business unit is the aggregate of firms owned or controlled by a single parent company. See H. Leak and A. Maizels, 'The Structure of British Industry', *Journal of the Royal Statistical Society*, 1945, Parts I-II.

Table 47. *Concentration of employment in the U K (1935) and U.S. (1939) brick industries*

U K (1935)			U S (1939)
Size group (number of employees in establishment)	Proportion of employment in the group (%)		Size group (number of wage-earners in establishment)
	U K	U S	
Up to 49	35	46	Up to 50
50-99	25	35	51-100
100 and over	40	19	101 and over
Total	100	100	

14% of all persons and produced 19% of the net output by value, i e the degree of concentration is relatively low

For the U S a similar type of information shows that in 1937 the four leading producers (defined somewhat differently from the British data) produced 5 6% of common bricks, 13 7% of facing bricks, 70 7% of hollow bricks and 81 7% of salt-glazed bricks * Thus the concentration in building brick production was smaller in the U S than in the U K

(ii) *Significance of productivity comparisons*

Productivity of labour as measured by output per man or per man-hour has been increasing in Britain throughout the last generation Between 1907 and 1935 the estimated increase in output amounted to 31% per man, and 47% per man-hour Part of this increase must be associated with the greater relative expansion of the Fletton group The increase in the productivity of labour was smaller in the brick industry than in manufacturing industry as a whole. In 1935 the estimated man-hours needed per 1,000 common bricks amounted to 15·4 man-hours.

In the U.S. the peak of labour efficiency had been reached in 1925 with 9 man-hours per 1,000 bricks. The greatest increase occurred between 1879 and 1909; since then the development has been slower In the inter-war period productivity of labour slightly declined with lower use of capacity, but there was an increase, in the period 1935–40, of about 7 5%

Comparing British and American output per man-hour we find that taking British output per man-hour in 1935 as equal to 100, U.S. output per man-hour amounted to 159 in 1935 and 171 in 1925 This comparison makes no allowances for the smaller size of the average American brick.†

At the same time, the mechanical equipment available per worker is much higher in the U.S. than in the U.K. In 1939 there was 8 28 horse-power available per worker in the U.S.; in Britain the latest figures relate to 1930 when 2·93 horse-power was available per worker and 2·77 horse-power was in use per worker (See Table 50(*c*).)

There has been far-reaching standardization of the product as between

* T N E C, Monograph 27, *The Structure of Industry*, 1941, pp 452-3

† According to Appendix IX of the Report of the Mission on Methods of Building in the U S., 18 U S A bricks=1 cu ft while 14 U K bricks=1 cu ft

firms and regions in the U S (standardization within the firm is of course a small problem or no problem at all in the brick industry) For both common bricks and facing bricks the number of sizes has been reduced from 75 to 2.

(iii) *Relative efficiency of different plants*

One of the factors which may account for these wide variations is the size of the plant

When analysing variations according to the size of the plant (establishment) in Britain, the pre-war 1935 data show positive correlation between size of output and output per head Comparing the value of net output per operative—an acceptable index when dealing with a fairly homogenous commodity—output increases, broadly speaking, continuously with increasing size, and the largest plants have about 50% higher value of net output per operative than the smallest plants Comparing physical output per operative, the continuity is broken by one size group, employing 100-199 persons, which shows a lower physical output than either the smaller or the bigger firms. Otherwise there is a continuous increase in output per head as the size of the plant increases. Plants in the largest size group now show nearly twice as high an output per operative as that in the smallest establishments.

It should be noted however that—although high-price producers assumed to produce mainly facing bricks have been left out of account—the unit price of product decreases as the size of the plant increases, and the comparability of the unit product produced by the different size groups is imperfect. In other words, bigger-sized establishments produce more bricks per worker, but more of cheaper bricks, and it is not quite certain whether they produce the same product as other, smaller establishments or whether they produce a cheaper quality.

In fact there is reason to believe that variation of output per operative with size of plant is due largely to the bigger average size of the Fletton producers, i.e if it were possible to separate completely Fletton and non-Fletton producers the variation of productivity with size would be much smaller.

In the U S. there is much more obvious inter-relationship between the size of plant and output per man-hour than in the British industry (See Table 49.) A sample investigation in 1929 covering 69 plants shows that, distinguishing between three size groups (plants with an annual capacity of less than 15 million common brick equivalent, 15–29 99 million, and 30 million and over), while the average man-hour requirements per 1,000 bricks for all plants amounted to 9 66 man-hours, the smallest plants produced 1,000 bricks at 11 48 man-hours, the biggest at 6 87 man-hours and the medium-sized plants at 9 82 man-hours Thus the biggest plants needed not quite half as much as the smallest, irrespective of the type of processes

Another factor which may affect these variations in productivity is the type of the process

We have attempted to estimate the approximate order of magnitude of labour requirements according to type of process and/or raw materials in 1935 Sand-lime brick production is treated as a separate product in the 1935

Census of Production, furthermore a group of Fletton producers was separated from the rest of the industry. The results of this estimate are as follows:

	Output per head ('000 bricks)	Man-hours needed per 1,000 bricks*
All brick producers, except a group of Fletton producers and sand-lime producers	120·0	20·8
A group of Fletton producers	262·0	9·6
Sand-lime brick producers	189·0	13·2
Average for industry as a whole	162·0	15·4

* From lack of other information actual average hours worked in October 1935—49·1 hours—have been used, and 51 working weeks assumed in all three cases.

Table 48. *Variations of labour productivity with size in the U.K. brick industry in 1935*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Size group (number of persons employed)	Number of establishments in the group	Weight of the group in % proportion of persons employed	Physical output per employee in thousands of bricks	Value of net output per employee in £	Physical output per operative in thousands of bricks	Value of net output per operative in £
11-24	92	6·5	120·6	198·3	130·8	215·3
25-49	208	27·0	135·4	207·1	142·4	217·8
50-99	97	24·2	136·3	219·5	141·8	228·4
100-199	30	14·4	105·0	271·9	111·9	289·6
200-299	10	8·8	199·4	266·8	203·5	272·4
300-399	4	4·5	224·9	290·9	227·7	294·6
400 and over	5	14·6	241·2	315·3	247·4	323·3
Total	446	100·0	157·8	233·0	165·2	243·9

Source. A sample of firms producing building bricks.

Table 49. *Variations of labour productivity with size in the U.S. brick industry*

Man-hours per thousand common bricks

(Based on a sample of 69 plants; data relate to 1929)

Annual capacity (millions of common bricks equivalent)	Stiff-mud process	Soft-mud process	Sand-lime and dry-press process	All processes
Less than 15	12·40	10·74	9·03	11·48
15-29·99	9·66	12·73	5·23	9·82
30 and over	6·99	5·91	—	6·87
All plants	9·67	10·33	8·27	9·66

Note. The investigation showed that in 1929 the least efficient plant had 6·4 times as high man-hour ratio as the most efficient, while in 1935, 27 times as high.

Source. Two studies of the Works Progress Administration National Research Project, 1939, quoted above. West, op. cit., Table 31, p. 120.

Table 50 *Average size of establishment, concentration of employment, and horse-power available in the U K and U S brick industries*

(*a*) *Average size of establishment*

	Number of operatives per plant	Output of bricks (common bricks equivalent) per plant
U S		
Common bricks, 1925	32	8,052
Facing bricks, 1925	59	16,006
Total,* 1925	38	10,009
Total,* 1935	24	4,800
U K		
Total, 1935	50	7,690

* Including hollow building bricks, etc

Sources U S Works Progress Administration, National Research Project *Studies*, West, op cit Tables 1 and 3

U K Based on *Census*, etc data

(*b*) *Concentration of employment in the different sized plants*

U K (1935)			U S (1939)		
Size group (number of employees in establishment)	% Proportion of establishments in the group	% Proportion of employment in the group	% Proportion of employment in the group	% Proportion of establishments in the group	% Size group (number of wage-earners in establishment)
			1	7	1-5
			11	32	6-20
11-24	23	7			
25-49	45	28	34	37	21-50
50-99	22	25	35	19	51-100
100-199	6	14			
			19	5	101 and over
200-299	2	9			
300-399	1	4			
400 and over	1	13			
Total	100	100	100	100	Total

Sources U K Board of Trade sample including high price producers Based on a sample of building brick producers

U S Brick and hollow structural tile trade as shown in the *Census*

(*c*) *Horse-power available in brick and fireclay industries*

U K			U S*	
Year	H P in use per operative	H P available per operative	Year	Rated h p per operative
1907	—	2 12	1909	—
1912	—	2 25	1929	—
1924	2 36	2 50	1939	8 28
1930	2 77	2 93		

* Brick and hollow structural tile trade

APPENDIX 7

COKE AND ITS BY-PRODUCTS

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

This industry includes firms engaged wholly or mainly in the manufacture of metallurgical coke and by-products at collieries or at blast furnaces where such plants are reported as independent units

The difficulty of comparison arises from the fact that although coke is the main product of the industry, it accounts only for about three-fifths of the value of output, while the rest is made up of by-products, such as gas, etc. For this reason the comparison is approximate

In the following tables the coke production *only* is related to the total number of operatives employed in the industry, on the assumption that the importance of by-products is the same in both countries.

II. COMPARATIVE DATA

Table 51. *Output, employment and productivity in the U K and U.S. coke industries*

	Output ('000 tons)	Value of coke output (million)	Value of total output of trade (million)	Employment	
				Operatives	All employees
U K (1935)	12,392	£9 6	£16 5	12,879	14,061
U S (1937)	46,760	$261	$357*	20,603	22,714
U S (1939)	39,575†	$213	$347*	21,693	23,854

* According to the *Minerals Yearbook*, 1940, p 864, the figures are
1937 $412 mill
1939 $355 mill

† 96·7% by-product coke, 3 3% beehive coke.

Table 52. *Comparison of productivity of labour in the U K. and U S coke industries*

	Output per employee (tons)	Output per operative (tons)	Index	Value of net output per operative
U K. (1935)	881	962	100	£323
U S (1937)	2,059	2,270	236	$4,096
U S (1939)	1,659	1,824	190	$3,950

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 53 *Average size of establishment, concentration of employment and horse-power per operative in the U K and U.S. coke industries*

(*a*) *Average size of establishment*

	Operatives
U K (1935)	114
U S. (1937)	219 (by-product plants 301)
U S (1939)	194 (by-product plants 253)

Table 53 (*b*) *Concentration of employment**

Size of establishment (number employed)	Number of establishments				% proportion of employment	
	U K (1935)	U S (1939)			U K (1935)	U S (1939)
		Beehive	By-product	Total		By-product
Up to 99 (100)	48	28	20	48	19%	6%
100 (101) and over	65	1	63	64	81%	94%
Total	113	29	83	112	100 0%	100 0%

(*c*) *Horse-power per* 100 *operatives*†

Rated h p per 100 operatives, U S (1939)	Beehive plants	2,175
	By-product plants	2,779
H P in use per 100 operatives, U K (1930)‡		642

* For the U K all 'employees', for the U S 'operatives' U S size groups in brackets

† For U K 'power in use' as computed in the U K *Census*, for U S 'power installed' as computed in the U S *Census*

‡ Including manufactured fuel.

APPENDIX 8

SEEDCRUSHING

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The seedcrushing trade of the British *Census* is compared with the cotton-seed oil, cake, meal and linters, linseed oil cake and meal and the soya bean oil, cake and meal industries in the U.S It appears that in both cases the activity of the industries concerned consists of both making unrefined oil (by crushing the seeds) as well as refining the crude oil Part of the British output consists of unrefined oil

II. COMPARATIVE DATA

Table 54. *Output, employment and productivity in the U K and U S. seedcrushing industries*

(*a*) *Output*

	Quantity		Average values	
	U K. (1935)	U S (1939)	U K (1935)	U S (1939)
	('000 tons)	('000 tons)	(£ per ton)	($ per ton)
Oil				
Unrefined	294 4	—	21 2	—
Refined	273 5	—	26 4	—
Total	567 9	1,085 0	23 7	147
Cake and meal	1,715 4	3,306 0	5 9	28
Total	2,283 3	4,391 0	—	—
Output index	100	192*		

* Based on re-valuing U K and U S output with respect to average values as well as on simple comparisons of quantity.

(*b*) *Employment*

	U K (1935)	U S (1939)
Estimated number of operatives producing output	10,200	16,700
Index	100	164
Average hours of work	47·5	44 3

(*c*) *Productivity*

	U K (1935)	U S (1939)
Output per operative tons	224	263
Index	100	117
Output per man-hour	100	125
Net output per operative	£454	$2,863

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 55 *Average size of establishment, concentration of employment and horsepower per operative in the U K. and U S seedcrushing industries*

(*a*) *Average size of establishment*

U K (1935)		199 operatives
U S (1939)	Cottonseed oil	34 ,,
	Linseed oil	84 ,,
	Soya bean oil	32 ,,
	Average	36 ,,

(*b*) *Concentration of employment**

Size of establishment (number employed)*	Number of establishments					Proportion of employment				
	U K (1935)	U S (1939)				U K (1935)	U S (1939)			
		Cotton seed	Linseed	Soya	Total		Cotton seed	Linseed	Soya	Total
						%	%	%	%	%
Less than 99 (100)	20	440	19	43	502	10	94	35	67	85
100-499 (101-500)	24	7	6	4	17	43	6	65	33	15
500 and over (501 and over)	5	—	—	—	—	47	—	—	—	—
Total	49	447	25	47	519	100	100	100	100	100

* For the U K all 'employees', for the U S 'operatives' U S size groups in brackets

(*c*) *Horse-power per* 100 *operatives*†

U.K (1930)		650 h p.
U S (1939)	Cottonseed	2,053 ,,
	Linseed	1,866 ,,
	Soya bean oil	2,127 ,,

† For U.K 'power in use' as computed in the U K *Census*, for U.S 'power installed' as computed in the U S. *Census*.

APPENDIX 9

COTTON SPINNING AND WEAVING*

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

A comparison between the *Census* groups of the two countries is not possible without previous adjustment, owing to the fact that the U S industry is differently organized (i e integrated) and as a consequence spinning and weaving are not recorded as separate industries The U S *Census* distinguishes between independent yarn mills ('cotton yarn trade') employing over one-sixth of the total labour force of the cotton trade and producing about one-fifth of all yarns, and the integrated cotton mills ('cotton broad woven goods') comprising the greater part of the spinning trade, the whole weaving trade and a part of the finishing trade

Before adequate comparison can be made between the two countries, separate estimates of the labour force engaged in spinning and weaving respectively have to be obtained The comparison is made between 'cotton spinning and doubling' of the United Kingdom *Census*, and the 'cotton yarn trade'

Table 56 *Productivity comparisons in the U K and U S spinning and weaving industries*

Year	Spinning: Total make of single yarn (mill lb)	Spinning: Corresponding number of operatives (estimated)†	Estimated output per operative, single yarn (lb)
	United Kingdom		
1935	1,228	133,340	9,210
1937	1,358	139,000	9,770
	United States		
	(1) Independent yarn mills		
1939*	677 5	66,000	10,265
	(ii) Integrated mills		
1939*	2,380 0	155,000	15,900-16,000
	(iii) All spinners		
1939*	3,057 5	221,000	14,700

Year	Weaving: Total output of piece-goods for sale (mill sq yds)	Weaving: Corresponding number of operatives (estimated)	Output per operative (sq yds)
	United Kingdom		
1935	3,344	122,400	27,320
1937	3,762	125,400	29,990
	United States		
1937	9,446	166,000	56,900
1939	9,045	150,000	60,300

* Corresponding estimates for 1937 cannot be made

† See note † on p 131

* This section summarizes the factual findings of the author's article in *The Economic Journal*, June-September 1945, on 'Productivity of Labour in the Cotton Industry' with the addition of some tabular material.

plus the estimated spinning section of the 'cotton broad woven goods' trade in the United States For weaving the other section of the 'cotton broad woven goods' trade is compared with the 'cotton weaving' trade of the U.K. *Census*

II. COMPARATIVE DATA

On the basis of the *Censuses of Production* the following detailed estimates of output per operative can be made for the two countries (see Table 56)

Actual hours of work in the U S amounted, according to Bureau of Labor records, to 36 2 hours in 1937 and 36 7 hours in 1939 In Britain there is no estimate for 1937, but for October 1935 Ministry of Labour data indicate 47 2 hours, and for October 1938 45 8 hours The quality of yarns spun has also to be considered In 1937 the average counts spun in the U K were 27's, and in the U S. 22's (and about the same in 1939), this would affect production per head by about 12%.* Taking into account both these factors in the case of spinning, and the first factor only in the case of weaving, the following estimates of productivity are arrived at †

	Output per man-hour	
	U K (1937)	U S (1939)
Spinning		
Independent yarn mills	100	112–120
Integrated spinners	100	175–185
All spinners	100	161–172
Weaving	100	250–260
Cotton industry total	100	200–210

* See *Cotton Board Trade Letter*, 14 December 1943, p 3

† The operatives have been estimated by reducing the total number shown for the trade by the ratio of the estimated value of total single cotton yarn produced to the total value of the output The former can be estimated, in turn, on the basis of the factory value of single cotton yarn sold For Britain, for the year 1935, another estimate can be made—on certain assumptions—for each yarn group, the weighted average of these estimates gives an output of single yarn per head somewhat above the 1935 estimate as shown above

The basic difficulty in comparing output per head in the cotton industry on the basis of the production censuses is to allocate satisfactorily the labour force in the integrated part of the U S trade among spinning, weaving, and finishing For purposes of this study the basis of allocation of the labour force has been taken from two Bureau of Labor studies on earnings in the cotton trade (*Monthly Labor Review*, April 1938 and December 1941 Additional information relating to the second enquiry has been kindly supplied by the U S Bureau of Labor Statistics) Both studies cover a large sample of the trade (about one-fifth of all operatives), and 'the sample was selected in such a way as to give adequate representation to mills of the various sizes, types and locations' In fact, the Bureau of Labor Statistics regards the labour pattern (i e the proportionate importance of different types of workers within the cotton trade) derived from the second study as so typical that it has been applied in subsequent years to estimate from current data of total employment the labour composition of the cotton trade The mills covered by the sample include independent yarn mills, mostly integrated mills, and an insignificant number of independent weaving-mills, but they exclude the finishing departments of the integrated mills On the basis of the 1937 sample it is estimated that about 52% of all operatives employed in the integrated mills have been working in their spinning departments, and in 1940 probably 53% Overhead labour has been excluded throughout Similar percentages have been applied to the labour force of the whole integrated trade as given in the *Census* By this method the number of persons employed in the integrated spinning-mills will be overestimated rather than underestimated, since no allowance has been made for the finishing section included in the integrated trade of the *Census* (but excluded in the Bureau of Labor sample).

For weaving, the same method has been used as for spinning In the case of Britain (in 1935) the sub-division 'Cotton piece-goods made for sale' of the cotton-weaving trade supplied the basic data As regards the U S , the estimated number of operatives in the integrated weaving-mills has also been overestimated by not allowing for the finishing section Independent weavers are too small in importance to affect these estimates

In addition to the above estimate based on the *Censuses*, i e. on the global performance of the two industries, another estimate on production per man-hour has been made by the Platt Report,* based on direct comparison of mill experiences in the two countries

The method applied by the Platt Commission was as follows·

Two teams with previously prepared questionnaires visited a number of American mills The comparison included spinning, preparation of the yarn, and weaving, covering in each case coarse, medium and fine work In each stage of manufacture the single processes making up that stage (such as mixing and feeding, blowing-room, carding, draw-frames, flyer-frames in the case of spinning) were dealt with separately, and the P M.H. evaluations have been made for comparable American and British mills having identical outputs of the same yarn counts and cloth types For spinning, three British practices, low-draft mule-spinning, low-draft ring-spinning and high-draft ring-spinning—the last method as an example of the most modern British practice—were compared with the prevalent American practice, high-draft ring-spinning For fine spinning, however, American low-draft ring-spinning was compared with British low-draft mule-spinning For preparation of the yarn, the American high-speed methods were compared with the typical and old-fashioned British practice, upright spindle-winder and beam-warper respectively. In weaving, for all types of cloth in the U S the automatic loom has been taken, while British practice for the coarse cloth is based on the four-loom system (with ring weft), and for medium and fine cloths on the six-loom systems, with hand-drawing and -twisting in each case.†

The method followed has not been based on a straight comparison of individual mills It would be almost impossible to find mills in the two countries and in the different fields of production which could be regarded as typically representative of American and British practice Even if they could be found, it is almost certain that their sizes would be so different as to make accurate comparison impossible Instead a method has been followed which combined sample investigation with engineering study.

For the U S , certain American mills have been selected in the coarse, medium and fine fields of production. From the evidence collected from a number of mills in each field, representative records of performance were computed, in order to evaluate the American P M H.

For Britain, the estimates are not based on the records of actual mills, but the performance was evaluated, on the basis of actual experience, of typical plants which were assumed to produce the same weight of the same yarn counts and cloth types as the American mills By adopting this procedure the mills compared are, in the matter of staffing, adequately representative of American and British industry, and the number of variables affecting the

* Ministry of Production, *Report of the Cotton Textile Mission to the United States of America, March-April* 1944 The *Report* states that 'as a measure of labour productivity the production per man per hour (subsequently indicated by P M H) has been selected' (op cit , p. v). The use of this abbreviation has been continued in the following discussion of the Platt Commission's findings concerning productivity in the cotton industry

† A detailed description of the method of comparison used is given in Part I and in Tables 4-25 of the Report.

issue (size of the plant, location, type and condition of the machinery used, etc.) is reduced to a minimum. In regard to U.S. experiences, the *Report* covered both Southern and New England mills, but mostly the former. Non-integrated mills have been considered in the fine-spinning field only. The *Report* claims that their data can be regarded as representative of labour productivity in the American mills visited and sufficiently accurate for its purpose. It was realized that those mills might not represent a true random sample of the entire American cotton spinning and weaving industry, but there are grounds for believing that, so far as labour productivity and mill equipment are concerned, the data given in the *Report* are representative of conditions in the *more up-to-date* section of the American cotton industry. The main findings of the *Report* in regard to P.M.H. can be seen from the summarised data below.

From the detailed data an estimate of output per man-hour in the cotton industry as a whole and its two main branches, spinning and weaving, in the U.K. and the U.S. can be attempted. For this, we must weight the different departments of the trade, the different qualities of the product (coarse, medium and fine counts), the different methods of production (ring- and mule-spinning, and low-draft and high-draft respectively), and so on. Such an evaluation will remain somewhat arbitrary, as some factors, such as size

Table 57. *Comparison, from Textile Mission Report, of U.K. and U.S. productivity*

(Production per man-hour in Britain taken as 100)

	Corresponding U.S. output per man-hour			
	Normal staffing		Present (war-time) staffing	
	Spinning			
Coarse count.				
Low-draft mule-mill	155		131	
Low-draft ring-mill	147		120	
High-draft ring-mill	136		112	
Medium count	Twist	Weft	Twist	Weft
Low-draft mule-ring	167	170	132	135
Low-draft ring-mill	182	198	149	163
High-draft ring-mill	156	167	128	137
Fine count	122			
	Preparation of the yarn			
	Spooling and winding		Beaming	
Counts				
12's	490		680	
20's	610		890	
30's	490		660	
60's	670		470	
	Weaving			
	Normal staffing			
Coarse-yarn cloth	233			
Medium-yarn cloth	303			
Fine-yarn cloth	229			

Note. In spinning, these relations were arrived at by comparing the particular British method (shown on the left-hand side of the table) with high-draft ring-mill method in the U.S.

of firms, location of industry and a number of quality differences, cannot be measured But, assuming that the mills chosen are really representative for the different types of product and methods of production, the tentative general comparison of output per man-hour as shown in Table 58 can be made

Table 58. *Weighted results of Textile Mission Report, output per man-hour*

	U K	U S
Spinning	100	161–5
Weaving	100	261–70
Industry as a whole	100	211–20

Note The following weights have been applied

(*a*) *Type of product* It has been assumed that the particular count chosen by the *Report* is representative for the whole group Coarse counts have been assigned a weight of 43 in Britain and 58 in the U S , medium counts 54 in Britain and 41 in the U S , and fine counts 3 in Britain and 1 in the U S (Based on *Census* data)

(*b*) *Equipment* Mule-spinning in Britain has been assigned a weight of 71 0, and ring-spinning 29 0 (Based on International Cotton Statistics, *International Cotton Bulletin*, October 1938) Within ring-spinning 2 9 weight has been attached to high-draft ring-spinning, the rest to low-draft ring-spinning No allowance has been made for the small number of mule spindles converted to high-draft (Unfortunately, no data are available to show how far the equipment is divided within the single quality groups)

(*c*) *Sections of Industry* In combining the spinning, preparation and weaving sections, employment of operatives has been taken as the basis, estimated from the *Censuses* For Britain the respective weights are 45, 8, 47, for the U S the estimated weights are 58, 3, 39 No direct estimate can be made for preparation, and its weight has been estimated from the *Report*

(*d*) *Weaving* For different types of cloth (coarse, medium and fine) the same weights have been taken as for yarns, since the export of yarns of different qualities is in much the same proportion as their total production An allowance has been made for the small proportion of non-automatic looms in the U S and for the small number of automatic looms in the U K

(*e*) *International Comparison* In comparing British and American output, two estimates were made in each case (the one using British weights, and the other American weights), and both sets of figures are given above

In comparing estimates of output per man-hour based on *Census of Production* data with those based on the *Report*, the following general considerations have to be taken into account· (1) The sample of the *Report* is representative only of the more up-to-date section of the U S industry; (ii) it has been assumed in the *Report* that the British plants are producing the standard counts given, and are not dividing up production among a wider range of counts, (iii) the labour force taken in the *Report* comprises actual mill operatives only, and does not include maintenance and repair, office, transport staffs, etc. For Britain the excluded personnel has been estimated at 8% of the labour force. No directly comparable estimates are available for the U.S., but an estimate for 1937 puts such labour at 6 6% and for 1940 at 7 4% of the total labour force * (i) and (ii) tend to offset each other, and on account

* See *Monthly Labor Review*, April 1938 and December 1941 The above percentages have been calculated on the basis of data referring to a sample investigation of earnings in the cotton trade Another estimate can be made with the aid of another Bureau of Labor study referring to 'Effects of Mechanical Changes in the Cotton Textile Industry, 1910 to 1936', *Monthly Labor Review*, August 1937 This study shows for certain types of cloth production somewhat higher percentages for 1936 than indicated above for the U S. It also shows that the overhead labour per unit of output has been increasing in the period 1910-36

of (iii) there does not appear to be an appreciable difference.

The two sets of estimates show a considerable degree of agreement. They both suggest that the British industry has more leeway to make up in weaving than in spinning. But the cotton industry as a whole seems to be no farther behind American standards of labour productivity than is British manufacturing industry in general One additional fact has been brought out by the *Census* comparisons that in spinning the differences in P M H. are due to high output per man-hour in the integrated part of the U.S industry, as P M H is only slightly higher (in 1937 it was even lower) in the independent yarn mills of the U S compared with the British spinning industry as a whole

Comparison with Japan

In addition to the comparison of British output per man-hour with the U.S., the country with the highest labour productivity, it is relevant also to quote comparative data for the Japanese cotton industry, as a typical, well-organized, low-cost producer. The latest data available* refer to the middle thirties, and present the situation there after a decade of rapid development In the middle thirties (1933) in Japan output of single yarns per operative amounted to 9,739 lb. and output of cloth per operative to 49,200 yards The data refer to the spinning and weaving mills of the Japan Cotton Spinners' Association, which represent about 97% of all spindles, but only one-quarter of the looms, the only modern looms in Japan † The above figures suggest that in spinning Japan is on the British level, while in weaving the more modern Japanese production per operative is near to the U.S. level, with the limitation that the estimated operating week is higher (about 53·9 hours) in Japan, also that the average cloth output per head for the Japanese industry, as a whole, must be appreciably below the above estimate.

Long-term changes in productivity of labour

Considering that the British cotton industry only a generation ago had a leading position in the world, it is surprising to find that its productivity should be considerably less than that of the U.S., and that it is being overtaken even by Japan. The explanation probably lies in the fact that, in the last thirty years before the war, the improvement in the British industry was smaller than in other countries:

* I L O , *The World Textile Industry*, 1937, vol I, p 299

† The Japanese cotton trade consists of three sectors (*a*) The Japan Cotton Spinners' Association controls practically all the spindles and about one-quarter of all looms The mills owned by members of the Association 'are similar in equipment and technique to the cotton mills of Europe and America They produce shirtings, T-cloths, sheetings, drills, sateens, and similar fabrics, most of which are 30 inches or more in width, and a large proportion of their cloth output, possibly 75%, is for export' The larger mills are completely integrated, and a substantial proportion of the looms is automatic.

'In addition to the Association mills which both spin and weave, there are a large number of smaller concerns which weave only, these operate both wide and narrow power-looms and produce mostly coloured goods, such as cotton crepe, tickings, ginghams and stripes, partly for export and partly for home consumption '

'A considerable part of the cloth for domestic consumption is still produced in Japan on handlooms, partly in the home, but more largely in small establishments of 5 to 50 looms each' See *United States Tariff Commission, Cotton Cloth Report*, No 112, Second Series, 1936, pp 146-61

Table 59 *Changes in output per man-hour in the cotton industry*

Year	U K †				U S ‡	Japan‖
	Spinning per operative	Weaving per operative	Total per operative	Total per man-hour§	Total per man-hour	Total per man-hour
1907			100	100		
1909			—	—	100	
1923			—	—	126	100
1924	100	100	93	—	—	—
1925	—	—	—	—	139	—
1929	—	—	—	—	152	—
1930	102	94	91	—	—	—
1931	—	—	—	—	158	—
1933	120	119	111	—	169	240
1934	121	118	111	—	—	—
1935	125	120	113	—	185	—
1937	137	134	126	146	195	—
1939	—	—	—	—	227	

Notes —=not available.

† Estimates computed on basis of the *Censuses of Production*

‡ S Fabricant, *Employment in Manufacturing*, 1899-1939, National Bureau of Economic Research, New York, 1942, p 285 Converted from indices of 'man-hours per unit'

§ Estimated on basis of changes in the working week from 55½ hours to 48 hours

‖ Estimated from data given in I L O., *The World Textile Industry*, 1937, vol I, p 299 Refers to Japan Cotton Spinners' Association mills only

In the thirty years before the 1939–45 war U S output per man-hour more than doubled, while British output increased by only 46% In the U.S these thirty years were a period of expansion, in spite of severe trade fluctuations The structure of the industry had already been crystallized by 1909 in its present predominantly integrated form The amount of mechanical equipment had increased and the quality of the equipment had been changing At the beginning of these thirty years, less than one-third of the looms were automatic; by the end of the period, 95%. Mules were almost completely replaced by ring-spindles (17% in 1909 as against 1% in 1939) Nevertheless, not the whole increase in labour productivity in the U S is due to purely mechanical factors. This can be seen from engineering studies such as that quoted in the *Report* (pp. VI-VII and Tables 1-3), which show that the potential effects of mechanical changes on output per man-hour in a comparable period have been substantially below the actual increases in output per man-hour This indicates that a number of (quantitatively not measurable) organizational factors have been operating to improve the American position, such as good technical management, good lay-out of plant, improvements in labour conditions.

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Among the many factors which affect the productivity comparisons are (*a*) the quality of the product, (*b*) the size distribution of establishments, (*c*) concentration of employment, (*d*) the composition of the labour force, and (*e*) the ratio of administrative to operative staff

Table 60 *U.K · Total make of single cotton yarn according to quality*

	1935		1937	
	lb ('000)	%	lb ('000)	%
Up to 20's (spun from raw cotton)	403,849	32·9	457,746	33 7
(spun from waste)	109,384	8 9	123,964	9 2
Over 20's up to 26's } Over 26's up to 40's }	497,672	40 5	181,826	13 4
			371,524	27 4
Over 40's up to 56's	101,821	8 3	108,943	8 0
Over 56's up to 80's	74,950	6 1	72,227	5 3
Over 80's up to 120's	36,991	3·0	37,133	2 7
Over 120's	3,098	0 3	4,411	0 3
Total	1,227,765	100 0	1,357,774	100 0

Table 61. *U S : Cotton yarn produced for own use and sale according to quality* (1939)

	Integrated cotton trade (cotton broad woven goods trade)		Independent cotton yarn industry (including cotton thread industry)	
	lb ('000)	%	lb. ('000)	%
20's and under	1,343,703	56 4	389,684	57 5
21's to 40's	906,208	38·1	230,725	34 1
41's to 80's	120,966	5 1	49,085	7·2
81's and over	9,218	0 4	7,861	1·2
Total	2,380,095	100 0	677,355	100 0

Table 62. *Size distribution of establishments* (based on *Censuses of Production* and *Manufactures*)

(*a*) *U K* 1935

Size group (number of employees)	Spinning		Weaving	
	% proportion of establishments	% proportion of employees	% proportion of establishments	% proportion of employees
Up to 10	6 9	0 2	9 3	0 4
11-24	6 7	0 6	7 5	0·9
25-49	11 9	2 1	12·7	3 3
50-99	13 0	4 6	19 8	10 2
100-199	20 5	14 6	27 0	26 9
200-299	19 4	22 9	11 8	19 9
300-399	9 4	15 8	6 8	16 1
400-499	5 5	11 7	2 7	8 2
500-749	4 0	11 6	1 5	6 0
750-999	1 6	6 3	0 3	2 0
1,000 and over	1·1	9 6	0 7	6 1
Total	100 0	100 0	100 0	100 0
Numbers	879	182,805	1,165	167,534

Table 62. (*b*) *U S* 1939

Size group (number of operatives)	Independent yarn spinners: % proportion of establishments	Independent yarn spinners: % proportion of operatives	Integrated cotton trade: % proportion of establishments	Integrated cotton trade: % proportion of operatives
1-5	2·3	0 04	1 8	0 01
6-20	6·0	0 33	5 5	0 15
21-50	7 7	1 20	7·1	0 50
51-100	15 8	6 20	5 9	1 44
101-250	43 8	35 70	21·7	8 20
251-500	16 9	26 93	28 4	22 20
501-1,000	6 6	22 40	19 4	29 30
1,001-2,500	0 9	7 20	9 4	29 60
2,501 and over	—	—	0 8	8 60
Total	100 0	100 0	100 0	100 0
Numbers	349	70,452	659	312,249

Table 63. *Average size of establishment, concentration of employment and horse-power per operative in the U K and U S cotton industries*

(*a*) *Average size of establishments*

U K (1935)	Cotton spinning	216 operatives
	Cotton weaving	152 ,,
	All cotton manufacture	180 ,,
U S (1939)	Independent yarn mills	202 ,,
	Integrated cotton trade	472 ,,
	All cotton manufacture	380 ,,
U S (1937)	All cotton manufacture	352 ,,

(*b*) *Concentration of employment in the U K and U S. cotton trade*

	U K (1935) Spinning %	U K (1935) Weaving %	U S (1939) Independent yarn mills %	U S (1939) Integrated cotton mills %
Percentage of employees (in U.K)* of operatives (in U S) employed in establishments having less than 50 employees (operatives)	2 9	4 6	1 6	0 66
100 ,, ,,	7 5	14 8	7 8	2 1
500 ,, ,,	72 5	85 9	70 4	32 5
1,000 ,, ,,	90·4	93 9	92 8	61 8

* The break-up of the U K classification of establishments is such that those having exactly 50 or 100 or 500 employees are put in the size group next above

(*c*) *Horse-power per* 100 *operatives**

U K (1930)	Cotton spinning	562 h p
	Cotton weaving	165 ,,
U S (1939):	Independent yarn mills	508 ,,
	Integrated cotton trade	480 ,,

* For the U K 'power in use' as computed in the U K *Census*, for the U S 'power installed' as computed in the U S. *Census*.

Table 64 *Composition of the labour force in the U.K and U S. cotton industries (operatives)*

(*a*) *Percentage of males and females*

(Based on *Censuses of Production* and *Manufactures*)

	Spinning		Weaving	
	1935	1937	1935	1937
U K				
Males	37 9	37·5	32 4	31 8
Females	62 1	62 5	67 6	68 2
Total	100 0	100 0	100 0	100 0

	Independent yarn mills	Integrated cotton mills	
U S (1939)			
Males	57 6	63 4	
Females	42 4	36 6	
Total	100 0	100·0	
Based on Bureau of Labor enquiries *			
	August 1934	April 1937	Sept 1940
Males in the sample	62 0	61 4	62·3
Females ,, ,,	38 0	38 6	37 7
Total	100 0	100 0	100 0

* Negro labour is uncommon, only about 2,600 of the workers being negroes out of a sample of nearly 90,000

(*b*) *Administrative, clerical and operative staff*

(Based on *Censuses of Production* and *Manufactures*)

	United Kingdom				United States	
	Spinning		Weaving		Independent yarn mills	Integrated cotton trade
	1935	1937	1935	1937	1939	1939
Salaried personnel as % of total personnel	3 2	3 1	3 9	4 0	2 8* 3·8†	3 0* 3·3†

* Salaried employees concerned with manufacturing only

† Including salaried personnel employed in distribution, construction and other not strictly manufacturing functions

APPENDIX 10

THE WOOLLEN AND WORSTED INDUSTRY

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The 'woollen and worsted' trade as defined by the British *Census* is compared with the 'woolen and worsted manufactures' trade in the United States *Census*. In order to cover the same range of industries 'woollen and worsted finishing' was included in the British trade, and the 'woolen and worsted carpet' industry (spinning and weaving) in the U S trade

The United States has practically only one finished product for sale: woven goods, whereas the British industry produces tops and worsted yarns for sale, as well as cloth When estimating the relative level of output in the two industries allowance is made for this factor, but the comparison cannot be as reliable as a separate comparison between cloth making, yarn making and top making would be Unfortunately no data are available to make such separate comparisons possible. For similar reasons it was not possible to allow for potential quality differences, or for a difference in the relative shares of the woollen and worsted sectors, although a rough estimate relating to the two sectors of the industry has been attempted

II. COMPARATIVE DATA

Table 65. *Output of the woollen and worsted industries of the U.K and U.S. in 1937**

	U K	U S
Intermediate products † (total make).		
Tops (mill. lb)	279	194
Noils ,, ,,	31	28
Yarns ,, ,,	566	577
Fabrics made for sale		
Tissues (mill sq yds)	475	533
(mill lb)	(304)	(353)
Blankets (mill lb)	25	25
Carpets ,, ,,	41	65

* For both countries the output of the industry also includes a few other items (such as wool scoured, wool waste, felts, etc) not specified in this table

† Including the carpet industry

Table 66 *Employment and hours of work in the woollen and worsted industries of the U.K and U S. in 1937*

	U K.	U S	Percentage ratio of U.S to U K
Average number of persons employed	262,000*	204,374†	78
Number of operatives employed	246,800	192,640	78
Actual average hours worked per week	45 5-49 2‡	35 3	

* Including the estimated number of persons employed in woollen and worsted finishing.

† Including the wool carpet industry.

‡ October 1935· 49 2, October 1938 45·5

Table 67. *Average values of goods produced and implied $ rate of exchange in the woollen and worsted industries in 1937**

	U K	of the U K and U S	Implied rate of exchange†
	£	$	$
Tops (per lb)	120	808	6 73
Noils ,, ,,	090	576	6 40
Yarns ,, ,,	150	1 311	8 74
Tissues (per sq yd)	117	947	8 09
(per lb)	182	1 431	7 86
Blankets (per lb)	114	987	8 66
Carpets (per sq yd)	339	2 294	6 77
Average ratio	1		7 40-7 80

* It should be noted that the above table shows average values at the factory (broadly speaking, factory prices) of the average product of the industry, but not necessarily of qualitatively comparable products

† This column is reached by dividing column (2) by column (1) The implied rate, of course, is approximate

Table 68 *Tentative comparison of output per head and per man-hour in the U K and U S woollen and worsted industries*, 1937

(*a*) *Comparison of the value of net output per head*

	U K	U S
Value of net output per employee	£180	$1,725
,, ,, ,, ,, ,, operative	£191	$1,826
U S Value of net output per employee converted at £1 = $4 90 rate Index	100	195
U S · Value of net output per employee converted at £1 = $7 50 rate* Index	100	128

* This is the rate corresponding to the ratio of average values given in Table 67 above and appears to be nearer to the 'wool products' exchange rate than the official exchange rate.

(*b*) *Comparison of physical output per head**

	U K	U S.
Output (methods A-C)*	100	100-104
Employment	100	78
Output per worker (methods A-C)*	100	130-140†
,, ,, man-hour ,, ,,	100	174-188

* Calculated by three different methods
(i) By revaluing U S and U K outputs at U S average values
(ii) By revaluing U S and U K output at U K average values
(iii) By comparing output of single products and weighting the ratios according to the value of net output
All three methods are based on the same basic data

† The following estimate was given in the U S *Foreign Commerce Weekly*, December 29th 1945. Output per worker, U K 1937, 1,760 sq yds , U S 1937, 3,380 sq yds The weight of a sq yd is in both cases 10½ ounces This estimate appears to be based on relating *total* employment to the output of tissues only and thus overestimates the U S advantage Part of the activity of the British industry consists of producing tops, yarns, etc , for sale abroad which are thus from their point of view final products D Skalka 'Export Angles of Britain's Woolen-Worsted Industry', *U S Foreign Commerce Weekly*, December 29th, 1945

Table 69. *Output, employment and output per operative in the woollen and worsted section of the U.K. and U.S. industries (rough approximation)*

(*a*) *Woollen section*

	U K (1937)	U S (1937)
Output		
Yarn (mill lb)	325	407
Tissues ,, ,,	199	210
Blankets ,, ,,	25	25
Carpets (mill sq yds)	41	65
Weighted output Index	100	approx 116-122
Operatives		
Numbers (1000's)	126	101
Index	100	80
Output per operative	100	145-153

(*b*) *Worsted section*

	U K (1937)	U S (1937)
Output:		
Tops (mill lb)	279	194
Noils ,, ,,	31	28
Yarns ,, ,,	241	170
Tissues ,, ,,	105	143
Weighted output Index	100	87-90
Operatives.		
Numbers (1000's)	120	93
Index	100	77
Output per operative	100	115-120

Table 70. *Long-term changes in output, employment and output per operative in the British woollen and worsted industry*

	1907 and 1912	1924	1930	1933	1934	1935	1937
Output·							
Tops	100	104	82	113	100	112	102
Noils	100	100	74	103	89	100	88
Yarns	100	110	76	101	103	108	112
Tissues	100	84	61	73	74	78	84
Blankets	100	90	92	109	109	108	104
Carpets	100*	89	88	117	129	143	159
Weighted output†	100	99	74	97	96	102	105 (100)‡
Employment·							
Operatives	100	101	87	85	86	88	90
All employed	100	102	85	87	88	90	92
Output per operative	100	98	85	114	112	116	117 (109)‡

* 1912 only

† Weighted according to the proportion of the value of net output of the items to the total net output in 1935.

‡ Index arrived at by revaluing 1907 and 1912 output at 1937 prices

Source (except for weighted output) *Facts and Figures about the British Wool Textile Industry*, appended to the report *Exports of Wool Textiles* 1942-3, prepared and presented by the National Wool Textile Export Corporation, Bradford, 1944, pp. 26 and 27

Table 71. *Long-term changes in output, employment and productivity in the U.K. and U S. woollen and worsted industries*

Year	Output		Employment (operatives)		Output per operative		Output per man-hour	
	U K	U S	U K	U S	U K.	U S	U K*	U.S
Average of 1907 and 1912	100	—	100	—	100	—	100	—
1909	—	100	—	100	—	100	—	100
1914	—	99	—	97	—	102	—	—
1923	—	117	—	119	—	98	—	110
1924	99	—	101	—	98	—	—	—
1925	—	105	—	101	—	104	—	118
1929	—	97	—	90	—	108	—	128
1930	74	—	87	—	85	—	—	—
1931	—	79	—	73	—	108	—	128
1933	97	84	85	78	114	108	—	—
1934	96	—	86	—	112	—	—	141
1935	102	113	88	99	116	114	—	161
1937	100-105	111	90	97	109-117	114	126-135	172
1939	—	113	—	91	—	124	—	178

* On the basis of a reduction in the working week from 55½ hours to 48.
Sources For U K See Table 70
For U S S Fabricant, *Employment in Manufacturing*, 1899-1939, National Bureau of Economic Research, New York, 1942, p. 288.

Table 72. *Recent changes in output, employment and productivity in the U.S. woollen and worsted industry*

Year	Output	Employment (operatives)	Output per operative	Output per man-hour
1939	100	100	100	100
1940	—	97 8	—	—
1941	—	124 2	—	—
1942	133 5	120 9	110 4	100 2
1943	138 0	111 9	123 3	107 9
1944	136 4	101 1	134 9	116 4
1945	127 9	94 7	135 1	118 2

Source U S Department of Labor, Bureau of Labor Statistics, *Productivity and Unit Labor Cost in Selected Manufacturing Industries* 1939-45, May 1946, mimeographed.

When considering the significance of these differences the particular characteristics of the British wool industry should be remembered. The industry as organized at present produces articles of great variety for a home market and even more so for a foreign market. It would require careful investigation to find out whether production could be more standardized than it is at present. Another factor which should be taken into account is the greater reliance in Britain on skill at all stages, for example in choosing the wool,* than in the U S industry.

* It has been suggested that the British are better wool men and thereby able to produce tops of high quality from wool of different degrees of irregularity Thus material costs are saved at the expense of some labour costs and somewhat higher man-hour requirements per unit

It has also been suggested that the British industry uses a higher proportion of poorer wool which requires more work The effect of these factors on total man-hour requirements per unit of cloth produced however, cannot be very great

Another aspect of the above comparisons is the extremely slow increase in productivity of labour when compared with the much faster progress in the U S. Our estimate shows that between 1907 and 1937 output per operative increased only by about 9-17% in the British wool industry, whereas the average increase for British industry as a whole was 47% during the same period; output per man-hour showed a 26-35% increase in the U.K. wool industry, compared with a 65% increase for total British industry, or with a 78% increase in the U.S. wool industry (between 1909-39). U S. output per operative increased by a further 35 1% and output per man-hour by a further 18 2% between 1939 and 1945.* A study of the reasons for the increase in the United States may throw some light on the causes of the lack of substantial progress in Britain.

The principal technological advances in the American industry may be summarized as follows†. in the weaving department the introduction of the automatic box loom which replenishes the filling supply without stopping the loom greatly decreased the amount of labour required to replenish the filling supply. It also stops automatically whenever a breakage occurs, and indicates the position of the broken warp thread Consequently the number of looms which a weaver can tend has been greatly increased. By 1940 about 66% of all looms were automatic.‡

In the spinning department the ring frame spindle has replaced the old-style mule and has the advantage that a much larger bobbin may be used on it; this eliminates a large amount of labour required in doffing and in the subsequent spooling and dressing operations.

Utilization of larger packages led to a complete change in the method of warp dressing in the spooling and dressing department. An entire intermediary process has been eliminated, formerly warp yarns were first wound from small bobbins on to jack spools and then on to creels, preparatory to dressing and being wound on to the loom beam. Today high-speed cone winders transfer the yarn from the spinning bobbins directly to the cones, which contain more yarn and are more suitable for dressing on the high-speed warper.

In the blending and picking department marked advances have been made by a continuous process which has eliminated the secondary re-processing formerly needed. Large feeders mix, weigh, and at intervals discharge the proper amount of stock on to a conveyor which delivers the mixture to the automatic feeder of the Fearnaught picker, the teeth of which separate the wool bunches and mix the fibres.

In the carding department the most important change has been the increase in the capacity of the carding machines. This has resulted in the reduction of their numbers and a consequent reduction in the number of tenders. The

* It should be borne in mind that the U K. wool industry has been severely curtailed The number of persons engaged declined from 224,000 in July 1939 to 138,300 in February 1945. The U.S. employment in the wool industry remained substantially unchanged (see Table 72).

† Boris Stern, 'Mechanical changes in the Woolen and Worsted Industries, 1910 to 1936', *Monthly Labor Review*, January 1938.

‡ In Britain about 10%

design and construction of the modern card permits easy and quick adjustment requiring a minimum of maintenance labour The capacity of the tape condensers which separate the web of wool into ribbons is more than twice that of the old ring doffers which they have generally replaced.

Similar advances have been made in the manufacture of worsted products The scouring equipment has been greatly increased in size with the result that there has been a material reduction in the number of overseers, driers and scouring men, soap and chemical labour Greater durability of machinery in the top-making department results in fewer hold-ups for repairs and adjustment of the machinery In the slashing department the utilization of larger section beams with greater speed and efficiency has resulted in a marked reduction in the number of slash tenders

III. FACTORS AFFECTING PRODUCTIVITY COMPARISONS

The following facts relate to differences in the structure of the wool industries in the two countries, and may serve as a background to an explanation of productivity differences

(1) *Specialization and integration*

In both countries the woollen and the worsted industry are virtually two different industries, and within each there is further far-reaching specialization There is much similarity between the U K and U S as regards the structure of the *woollen* industry In both countries the woollen industry is largely integrated. In the *worsted* branch, on the other hand, there is much specialization in the U K , and firms are frequently concerned with single processes only. It is therefore possible to distinguish between wool buyers, top makers and combers, spinners, warpers and sizers, manufacturers (i.e. weavers), dyers and finishers. The distinction between the vertically organized woollen branch and the sectionally organized worsted branch is of course not absolute in the U.K. There are vertically organized firms in the worsted branch (mainly in the mohair and alpaca trades) while many firms in the woollen branch limit their operations to one or two processes Nevertheless the main type of organization is easily recognizable and there have been no fundamental changes during the last generation or so In the worsted branch of the U.S. there has been far more integration than in Britain. Some tendencies towards more sectional organization (especially of specialized top making and commission combing) appear to be of recent origin

The well-informed study of the Industrial Research Department of the Wharton School of Finance and Commerce on *Vertical Integration in the Textile Industries** points out that over the fifteen or twenty years before the war specialized weaving companies in the worsted field steadily lost ground to the companies doing both spinning and weaving. At the same time these companies increasingly buy tops instead of wool. It has been estimated that about 50% of the wool consumed by worsted mills was bought in 1938 in the

* Philadelphia, 1938, p 76

form of top as against 25% or less in 1928. This trend is explained by a desire to reduce inventory risks and to more effective use of their working capacity.

A fairly comprehensive picture of specialization and integration can be derived from the *Censuses* * In some respects the *Census* data do not give full evidence on integration, for they would register as separate units the parts of an integrated mill if separate accounts were available Moreover the *Census* does not distinguish between independent weavers and integrated spinners-weavers.

The 1935 U.K. *Census* registers 1,622 establishments with 10 or more employees employing in round figures 250,000 persons of whom 83,000 are employed in the woollen section, 120,000 in the worsted section and 47,000 in other sections (of which 30,000 are in carpet weaving) In the woollen section—not taking into account the manufacture of recovered wool—over nine-tenths of the employees are working in the 479 integrated firms, and less than one-tenth in 67 independent spinning firms In the worsted section about one-fourth of the employment is in the 96 integrated establishments, while the 521 other firms are specialized. In the third group the 63 establishments of wool merchants and the 144 establishments doing commission work also largely serve the worsted industry There are 104 independent establishments with 8,600 employees doing woollen and worsted finishing The 98 establishments employing 30,000 people in carpet weaving form an industry which is quite independent of the woollen industry

In the U S , taking the same year, 1935, the bulk of the employment of the woollen section is in 323 integrated mills, less than 5% being employed by the 43 independent yarn mills In the worsted section nearly three-quarters of the employment is in the 167 integrated mills and 12 wool combing firms working on commission basis There are 66 independent dyers and finishers, fewer than in Britain and employing a small labour force

(ii) *Average size of establishments*

Measuring the average size of establishments by the number of persons employed—as shown in the *Census* reports—the average establishment appears to be bigger in the U S. than in the U K. In 1935 the average U.S establishment employed 269 persons, while the average U.K establishment employed only 155 persons. In both cases carpet weaving is included In both countries the average establishment is smaller in the woollen branch than in the worsted branch. The average independent yarn spinner is much smaller than the average integrated firm in the woollen section and the same is true for the worsted branch The average U.S. establishment is larger in terms of employment and output in all cases except in that of independent finishers The larger average size of the worsted mills is explained by the fact that in the U.S. the worsted industry produces fewer varieties than the woollen industry, which therefore requires more flexibility.

* Additional information on size of establishments in the U S can be found in the *Annual Bulletin* of the National Association of Wool Manufacturers

Table 73 *Number of establishments, employment and average size of establishments in the different sections of the woollen and worsted industries of the U K. and U.S*

(*a*) *U K.* 1935

	Number of establishments	Number of employees	Average size of establishments (number of employees)
Woollen Section			
Manufacture of recovered wool	50	1,816	36
Spinning (independent)	67	5,871	88
Weaving (including integrated firms)	479	75,296	157
Total	596	82,983	139
Worsted Section			
Topmaking	11	1,355	123
Commission weaving	51	8,740	171
Spinning only	264	59,958	227
Spinning and weaving	96	30,270	315
Weaving only	195	19,762	101
Total	617	120,085	195
Other Groups			
Wool merchants	63	2,445	39
Commission work	144	7,148	50
Woollen and worsted finishing	104	8,567	82
Carpet weaving	98	29,548	302
Total	409	47,708	117
All sections	1,622	250,776	155

Table 73 (*b*) *U S* 1935 *and* 1937

	No of establishments		No of operatives		No of employees	Average size of establishment		
	(1937)	(1935)	(1937)	(1935)	(1935)	Operatives (1937)	Operatives (1935)	Employees (1935)
Woollen								
Yarn (independent)	41	43	2,749	2,909	3,115	67	68	72
Woven goods (integrated)	332	323	61,931	64,986	68,651	187	201	213
Total	373	366	64,680	67,895	71,766	173	186	196
Worsted								
Yarn (independent)	71	68	17,303	19,097	19,846	244	281	292
Woven goods (integrated)	176	167	70,227	72,068	75,866	399	432	454
Wool combing (on commission)	11	12	3,252	2,648	2,792	296	221	233
Total	258	247	90,782	93,813	98,504	352	380	399
Other branches								
Wool scouring	20	20	1,252	1,527	1,680	63	76	84
Woollen and worsted dyeing and finishing	53	66	2,563	3,369	3,864	48	51	58
Wool carpets	55	55	30,779	27,633	29,781	560	502	541
Woollen and worsted carpet yarn	15	16	2,584	1,176	1,245	172	73	78
Total, excluding carpets	704	699	159,277	166,604	175,814	226	238	252
Total, including carpets	774	770	192,640	195,413	206,840	249	254	269

U S (1939) 783 establishments, 178,642 operatives, 228 operatives per establishment

Sources. U K *Census of Production*, U S *Census of Manufactures*

(iii) *Concentration of employment*

In the U.S wool industry not only is the average establishment bigger, but a higher proportion of employment is concentrated in the larger establishments.

Table 74 *Concentration of employment in the U K and U S woollen and worsted industries*

(Excluding independent finishers, but including carpet making)

Size of establishment (number of employees for U K, operatives for U S U.S size groups in brackets)	No of establishments			% proportion of employment		
	U K (1935)	U S (1939)		U K (1935)	U S (1939)	
		Including carpets	Excluding carpets		Including carpets	Excluding carpets
				%	%	%
Up to 99 (100)	815	324	301	16	7	8
100-499 (101-500)	620	331	307	54	46	49
500-999 (501-1,000)	64	37	30	18	14	13
1,000 (1,001) and over	19	28	21	12	33	30
Total	1,518	720	659	100	100	100

The above figures relate to establishments (plants) and are thus more relevant to the technical aspects of production The concentration of business units is more relevant to the economic aspects

Table 75. *Size of unit and concentration of employment in the U.K. woollen industry*, 1935*

	No of business units employing 500 persons	% of employment in three largest business units
Woollen and worsted	102	6
Woollen spinning only	7	17
Carpets	19	29
Blankets, etc	5	33
Other woollen fabrics	27	7
Commission combing	4	50
Worsted spinning only	32	20
Worsted weaving only	14	9
Worsted spinning and weaving	22	19

* H Leak and A Maizels, 'The Structure of British Industry', *Journal of the Royal Statistical Society*, 1945, pp 142 ff

This table shows that although the number of establishments in the woollen industry is extremely great, only about 100 big business units operate in the industry. In most of the branches of the industry there is little concentration in the sense of a high proportion of employment being controlled by a small number of units The exception is commission combing, where half the employment is in the three largest units There is also some degree of concentration in blanket and carpet making If it were possible to distinguish different products within each of the above *groups*, concentration would no doubt be much higher

U S. concentration data relate to products and indicate a very high degree of concentration in the woollen industry Among the 31 products enumerated, in 15 cases half the output is produced by the 4 biggest producers *

* *The Structure of Industry*, Temporary National Economic Committee Monograph 27, Washington 1941, pp 433-4

Table 76. *Horse-power per* 100 *operatives in the U K and U S woollen industries**

U K (1930)	Woollen and worsted	204 h p
U S (1939)	Woollen and worsted (regular factories)	370 ,,
	,, ,, ,, (contract ,,)	324 ,,
	Carpet yarn (woollen and worsted)	295 ,,
	Carpets and rugs (wool)	284 ,,

* For U K. 'power in use' as computed in the U K *Census*
For U S 'power installed' as computed in the U S *Census*

APPENDIX 11
RAYON

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

Comparison is difficult owing to the fact that in the British *Census* the different branches of the artificial silk industry are treated as sub-groups of the 'silk and artificial silk trade', and also because it is difficult to make a clear-cut division between the several sectors of the rayon industry

Broadly speaking two main sections can be distinguished (*a*) The producers, the rayon—or artificial silk—industry proper who are engaged in making (i) continuous filament rayon yarns, and (ii) rayon staple fibres This section of the industry is classified in the British *Census* as 'artificial silk manufacturers', but in the U S *Census* as 'rayon and allied products' (classified in the chemicals and allied products group) (*b*) The users of rayon, i e firms making rayon fabrics (out of rayon yarns); spinning so-called 'spun rayon yarn' out of rayon staple fibre (which is largely done on the cotton system), and weaving spun rayon fabrics out of spun rayon yarn This section of the industry comes in the British *Census* under 'silk and artificial silk weaving', while in the U S. *Census* it comes under rayon manufacturers, with five sub-groups distinguished. (i) rayon broad woven goods—regular factories or jobbers engaging contractors, (ii) the same—contract factories, (iii) rayon narrow fabrics (these are the three groups of weavers); (iv) rayon yarn and thread, spun or thrown—regular factories or jobbers engaging contractors, (v) the same—contract factories (these two are concerned with spinning of 'spun rayon yarn')

Owing to quick technological changes in this industry, an estimate has been attempted for 1939 in the U K The estimates are necessarily conjectural

II. COMPARATIVE DATA

Table 77 *Output, employment and productivity in the U K and U S rayon industries*

(*a*) *Output and employment, UK* 1935-9

		1935	1937	1939
Artificial silk produced				
Single yarns and straw	(mill lb)	111 9	—	120 0
Waste (including staple fibre)	,,	12 5	—	—
Staple fibre (including waste)	,,	—	—	61 2
Total	,,	124 4	154 8	181 2
Average number of persons employed		34,808	—	—
Estimated number of operatives producing output		30,000	—	23,900*
Actual average hours worked (weekly)		46 0	44 2†	—

* Estimated on the basis of social insurance statistics

† At October 1938

Sources Census of Production and *Preliminary Report No* 3 of the *Import Duties Act Inquiry*, 1937, published as a supplement to the *Board of Trade Journal*, 13 July 1939, *Board of Trade Journal*, 9 March 1946, p 265 For hours of work, *Ministry of Labour Gazette*

Table 77 (*b*) *Output and employment, U S* 1935–9

		1935	1937	1939
Artificial silk produced				
Rayon yarn	(mill lb)	257 6	321 7	328 6
Staple fibres	”	—	20 2	51 3
Waste	”	—	11 2	12 6
Total	”	257·6	353·1	392 5
Operatives in the trade		50,550	55,098	48,332
Estimated operatives producing output*		40,000	46,000	39,000
Actual average hours worked		37 9	38 5	37 9

* Based on ratio of rayon output by value, to total gross output of trade

(*c*) *Productivity comparisons*

	Output per worker						Output per man-hour*			
	Rough comparison			Adjusted for proportion of staple fibres*			Rough comparison		Adjusted for proportion of staple fibres*	
	lb	Index		lb	Index		Index		Index	
		U K 1935=100 base	U K 1937=100 base		U K 1935=100 base	U K 1939=100 base	U K 1935=100 base	U K 1937=100 base	U K 1935=100 base	U K 1939=100 base
U K. (1935)	4,150	100	—	3,930	100	—	100	—	100	—
(1937)	5,400†	—	100	—	—	—	—	100‡	—	—
(1939)	7,580	—	—	6,280	—	100	—	—	—	100‡
U S (1935)	6,440	155	—	—	—	—	188	—	—	—
(1937)	7,680	185	142	7,320	186	—	221	170	222	—
(1939)	10,060	242	—	9,000	229	143	294	—	278	167

* 2 lb of staple fibre or waste taken as equal to 1 lb of single yarn (a ratio broadly corresponding to pre-war relative average values)
† Based on the estimated increase in productivity in the artificial silk industry in the 1935-7 period
‡ Assuming the same hours worked as in 1935

Table 78. *Output, employment and productivity in the U K. and U.S. rayon weaving industries*

(*a*) *U.K* 1935*

	Mill sq yds	Mill lb	Mill £
Total amount of piece-goods of artificial silk, pure or mixed, made	380	80	17
Made in other industries	154	33	6
Made in the silk and artificial silk industry	226	47	11
Estimated number of operatives†	23,500		
Actual average hours worked per week	46 9‡		

* Disregarding such activities as doubling, twisting, preparation, etc., in both countries, only one activity, weaving, is taken into account

† Estimated on basis of the ratio of the value of main products to the value of total output.

‡ Silk and artificial silk weaving

(*b*) *U S* 1935-9

	1935	1937	1939
Rayon and rayon mixtures broad woven goods *			
Mill lb	160	211	335
Mill linear yds	775	1,002	1,341
$ mill	160	222	273
Estimated number of operatives†	53,000	54,800	68,500
Actual average hours worked per week‡	34 8	35 9	36 9

* The output appears to include cloth made in other industries, but excludes cotton, etc goods woven on the rayon system

† Estimated on the basis of the ratio of the value of main products to the value of total products

‡ Silk and rayon goods

(*c*) *Comparison of output per worker*

	Output per worker			Output per man-hour	
		Index		Index	
	lb	U K 1935=100 base	U K 1937=100 base	U K 1935=100 base	U K 1937=100 base
U K, 1935	2,000	100	—	100	—
1937	2,580*	—	100	—	100†
U S, 1935	3,000	150	—	202	—
1937	3,850	193	149	251	195
1939	5,110	245	—	315	—

* Based on the estimated increase in productivity in the artificial silk industry in the 1935-7 period

† Assuming the same working hours as in 1935

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 79. *Average size of establishment, concentration of employment and horse-power per operative in the U K. and U S rayon industries*

(a) *Average size of establishment*

U K artificial silk	1935	1,800 operatives
U.S rayon and allied products	1935	1,580 ,,
	1937	1,670 ,,
	1939	1,611 ,,
U K. silk and artificial silk weaving	1935	172 ,,
U S broad woven goods (regular and contract factories)	1935	214 ,,
	1937	243 ,,
	1939	254 ,,

(b) *Concentration of employment**

	Size of establishment (number employed)			
	Up to 99 (up to 100)	100-999 (101-1,000)	1,000 & over (1,001 & over)	Total
(i) Number of establishments				
U K (1935)				
Silk and artificial silk (total)	183	136	14	333
U S (1939)				
Silk and artificial silk (total)	544	280	35	859
Rayon and allied products	2	12	16	30
Rayon broad woven goods (regular and contract factories)	138	120	17	275
(ii) Proportion of employment				
U K (1935)				
Silk and artificial silk (total)	10	43	47	100
U.S (1939):				
Silk and artificial silk (total) of which:	11	49	40	100
Rayon and allied products†	—	13	87	100
Rayon broad woven goods (regular and contract factories)	8	56	36	100

* For the U K all 'employees', for the U S 'operatives' U S size groups in brackets

† To avoid disclosure of individual establishments, employment data have been combined with the next size group

(c) *Horse-power per* 100 *operatives*‡

U K silk and artificial silk	1930	164 h p
U.S rayon and allied products	1939	944 ,,
Broad woven goods		
Regular factories	1939	234 ,,
Contract factories	1939	138 ,,

‡ For the U K 'power in use' as computed in the U K *Census*, for the U S 'power installed' as computed in the U S *Census*

APPENDIX 12
LINOLEUM AND OILCLOTH
I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

In the British *Census of Production* the trade comprises firms that are engaged wholly or mainly in the manufacture of linoleum, oilcloth, other floor coverings and leather cloth

In the American *Census* the same products are classified into two trades: the linoleum, asphalted-felt-base and other hard-surface floor coverings trade, and the artificial leather and oilcloth trade

No allowance has been made for quality differences and thus the comparison is approximate

II. COMPARATIVE DATA

Table 80 *Output, employment and productivity in the U K. and U S linoleum industries*

(a) Output

	Quantity (th sq yds)		Value (£ mill $)		Unit value per th sq yds £ $	
	U K (1935)	U S (1939)	U K (1935)	U S (1939)	U K (1935)	U S. (1939)
Linoleum						
Inlaid	19,841	27,392	2 2	21 6	109 9	789
Other	42,667	8,294	2 7	7 5	64 3	904
Total	62,508	35,686	4 9	29 1	78 4	815
Cork carpet	659	318	0 1	0 3	145 8	1,031
Felt base floor coverings	42,270*	166,567	1 0*	37 9	24 3*	227
Oilcloth for floor coverings	6,879	96,115	0·3	13 2	39 2	137
Leather cloth (artificial leather for the U S)	49,155	100,962	2 8	28 2	57 5	279
Weighted output	100	145-180†				

* Excluding felt, sold as such
† Weighted with U S and U K unit values respectively

(b) Employment

	U K (1935)	U S (1939)
Average number of persons employed		
Linoleum	—	7,694
Artificial leather	—	4,610
Total	12,455	12,304
Number of operatives employed		
Linoleum	—	7,028
Artificial leather	—	3,976
Total	10,809	11,004
Estimated average number of persons producing output*	12,455	11,800
Estimated number of operatives producing output*	10,809	10,550
Actual hours of work	49 1	—
Ratio of employed persons	100	95
Ratio of operatives	100	98

* Allowing for other products of the trade

Table 80 (*c*) *Productivity comparisons*

	U K (1935)	U S (1939)
Output per employee (index)	100	153-189
Output per operative (index)	100	148-184
Value of net output per operative	£419	$5,425

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 81 *Average size of establishment, concentration of employment and horse-power per operative in the U K and U S linoleum and oilcloth industries*

(*a*) *Average size of establishment*

U K (1935)	284 operatives
U S. (1939)	
Linoleum	413 ,,
Artificial leather	110 ,,

(*b*) *Concentration of employment**

Size of establishment (no employed) U K	Number of establishments			Proportion of employment			Size of establishment U S
	U K	U S linoleum	U S artificial leather	U K	U S linoleum	U S artificial leather	
Up to 99	21	6	25	7	4	27	Up to 100
100-999	11	9	11	26	25	73	101-1,000
1,000 and over	6†	2	—	67†	71‡	—	1,001 and over
Total	38	17	36	100	100	100	Total

(*c*) *Horse-power per* 100 *operatives*§

U S. (1939):	
Linoleum trade	822 h p.
Artificial leather	459 ,,
U K. (1930)	444 ,,

* For the U K. all 'employees,' for the U S 'operatives'.
† 750 and over.
‡ 501 and over
§ For the U.K 'power in use' as computed in the U K. *Census*, for the U.S 'power installed' as computed in the U S *Census*

APPENDIX 13

PAPER

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

In comparing the paper trade of the U.K. with the paper and paper-board mills of the U.S., it should be borne in mind that the U.S. paper mills are (*a*) integrated with pulp mills (although they are treated as a separate *Census* industry, and thus do not cause statistical complications), and (*b*) they also produce a great quantity of converted paper products. In order to compare the same processes the paper production only of the U.S. mills has been taken into account (i.e. the paper sold plus the paper used in own plant for making paper products) while the activity concerned with making converted paper products was disregarded.

One item, coated paper, is treated in Britain as a paper-mill product and consequently the coated paper production of the U.S. mills has been taken into account.

Because of great differences in the product structure of the two industries (as shown in Table 82) two comparisons have been made for output: (i) based on weight of physical output, (ii) with constituents of physical output revalued at British and U.S. prices. Comparisons are necessarily approximate.

Table 82. *Product structure and average values in the U.K. and U.S. paper industries*

Product structure, % of output			Average values	
	U.K. (1935) %	U.S. (1939) %	U.K. (1935) £ per ton	U.S. (1939) $ per ton
(1) Newsprint	38.1	7.1	9.4	46.7
(2) Other printing paper	17.4	14.6	19.9	87.5
(3) Writing paper	6.5	4.4	33.2	158.1
(4) Packing ,,	15.2	15.6	15.8	79.8
(5) Tissue ,,	0.3	4.9	115.7	545.3
(6) Blotting ,,	0.3	0.9	64.8	179.8
(7) Roofing ,,	1.2	4.9	12.0	52.9
(8) Coated ,,	4.5	2.0	42.0	196.9
(9) Other ,,	2.2	0.4	35.6	101.2
(10) Board	14.3	45.2	14.8	45.6
Total	100.0	100.0	£17.1	$73.1

II. COMPARATIVE DATA

Table 83 *Output and employment in the U.K. and U.S. paper industries*

(*a*) *Output of paper and paper-board mills*

U.K. category	U.S. category	U.K. (1935) ('000 tons)	U.S. (1939) ('000 tons)
(1) Newsprint	Newsprint	857·3	852·0
(2) Other printing paper	Groundwood printing and speciality papers	391·8	482·0
	Book paper	—	1,243·0
	Cover ,,	—	17·0
	Text ,,	—	11·0
	Total other printing paper	—	1,753·0
(3) Writing paper	Writing paper (fine)	146·3	531·0
(4) Packing and wrapping paper	Wrapping ,,	343·0	1,872·0
(5) Tissue and cigarette ,,	High-grade tissue paper	6·7	15·0
(6) Blotting paper	Absorbent paper	6·0	109·0
(7) Roofing ,,	Building ,,	28·2	588·0
(8) Coated paper, oiled, waxed and other waterproof paper	Coated and glazed paper	101·4	254·0*
(9) Other paper	Other paper, including tissue (except high-grade tissue)	50·9	636·0
(10) Board	Boards	321·4	5,451·0
		2,253·0	12,061·0

* Only coated paper made in the paper and paper-board mills is included. As approximately half of the value of coated and glazed paper produced by paper mills was book paper and the other half wrapping paper, quantities of paper to this extent have been deducted from the respective columns in order to avoid duplication.

(*b*) *Index of output, U.K. 1935=100*

	U.K. (1935)	U.S. (1939)
(1) Based on physical weights	100	535
(2) Output revalued at U.K. prices	100	570
(3) Output revalued at U.S. prices	100	500

(*c*) *Employment*

	U.K. (1935)	U.S. (1939)
Total number of operatives	54,515	110,575
Total number of employees	59,748	122,893
Estimated number of operatives producing output	51,827*	105,000†
Estimated number of employees producing output	56,802*	116,150†
Actual hours of work per week	48·2	40·3‡
Ratio of operatives	100	203
Ratio of employees	100	204

* Adjusted on the basis of the following data: total value of gross output of the trade £40·6 millions, of which £38·5 millions are paper and board.

† Adjusted on the basis of the following data: total value of gross output of the trade $933 millions, of which $757·7 millions represent paper and board made and sold, another $89·6 millions represent the value of paper and board made and used in the same plants in the manufacture of converted paper products. A further $33 millions have been added on account of 'value added' for coated paper produced in the paper mills. The figures were rounded upwards to make a further allowance on account of the latter.

‡ Paper and pulp industry.

Table 83. (*d*) *Productivity*

	U K (1935)	U S (1939)
Output per employee (tons)	39·7	103 8
Output per operative (tons)	43·5	114 9
Index (1) Based on physical weights	100	264 } 263
Index (2) Output revalued at U K prices	100	280 } 263
Index (3) Output revalued at U S prices	100	246 } 263
Output per man-hour index (operatives)	100	315
The value of net output per operative	£309	$3,624

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 84 *Average size of establishment, concentration of employment and horse-power per operative in the U K. and U S. paper industries*

(*a*) *Average size of establishment*

U K 1935 204 operatives
U S 1939 173 „

(*b*) *Concentration of employment**

Size of establishment (number employed)	No of establishments		% proportion of employment	
	U K (1935)	U S (1939)	U K (1935)	U S (1939)
			%	%
Up to 99 (100)	111	296	9	13
100-999 (101-1,000)	151	335	76	79
1,000 (1,001) and over	5	7	15	8
	267	638	100	100

(*c*) *Horse-power per* 100 *operatives*†

U S 1939 per 100 operatives 2,799 h p ‡
U K 1930 „ „ „ 915 „

* For the U K all 'employees', for the U.S 'operatives' U S size groups in brackets
† For U K 'power in use' as computed in the U K *Census*, for U S 'power installed' as computed in the U S *Census*
‡ Including pulp mills

APPENDIX 14

RUBBER TYRES AND TUBES

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The main product of the industry is outer covers for motor car tyres, but there are a number of other types of tyres and tubes. The output comparison is therefore based on calculating a weighted index of the output ratios, the weights being their relative average values per unit of output.

Within the main product group, namely outer covers for motor cars, the U.S. classification distinguishes between outer covers for passenger cars and outer covers for trucks, the latter having a much higher unit value. There is some presumption that the latter are proportionately more important in Britain than in the U.S.* But it is not possible to make allowances for this factor.

Apart from tyres and tubes the trade produces a number of other rubber products. In the U.K. 74% only, in the U.S. 83% and 87% respectively (in 1937 and 1939) of the value of the output are accounted for by tyres and tubes, in consequence the number of employees and operatives has to be estimated on the basis of the ratio of tyre output to the value of total output.

For the U.K. tyres and tubes are a sub-group of the rubber industry.

Estimates are approximate.

* On the basis of output of vehicles and vehicles in use

II. COMPARATIVE DATA

Table 85. *Output, employment and productivity in the U.K. and U.S. rubber tyres and tubes industries*

(a) Output

	U.K. (1935) ('000's)	U.S. (1937) ('000's)	U.S. (1939) ('000's)	Ratios (1937)	(1939)
Pneumatic outer covers for motor cars, etc	6,223	54,113	57,770	8·7	9·3
for motor cycles and bicycles	10,637	5,766	7,220	0·5	0·7
Inner tubes for motor cars, etc	4,437	52,398	51,278	11·7	11·5
for motor cycles and bicycles	9,946	3,564	5,060	0·4	0·5
Solid tyres for motor cars, etc	18	254	217	14·1	12·0
Weighted index of output*	100	790-900	840-925		

* Weighted by average value per unit of each item both in the U.K. and in the U.S.

Table 85 (*b*) *Employment*

	U K (1935)	U S (1937)	U S (1939)
Value of tyres and tubes output	£13 6 mill	$477 mill	$503 mill.
Total value of output of trade	£18·3 mill	$576 mill.	$581 mill.
Correction factor	0 74	0 83	0 87
Average number of persons employed in trade	28,127	74,242	63,131
Operatives employed in trade	23,200	63,290	54,115
Estimated number of persons employed producing tyres and tubes	20,800	61,600	54,900
Estimated number of operatives employed producing tyres and tubes	17,200	52,500	47,080
Ratio of persons employed	100	296	264
Ratio of operatives employed	100	306	274
Actual hours of work per week	48 6*	31·8	35·0

* Rubber goods

(*c*) *Productivity*

	U K (1935)	U S (1937)	U S (1939)
Output per employee	100	267-304	320-330
Output per operative	100	258-294	310-320
Output per man-hour (operatives)	100	422	437
Value of net output per head	£392	$3,302	$4,268

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 86 *Average size of establishment, concentration of employment and horse-power per operative in the U K. and U S. rubber tyres and tubes industries*

(*a*) *Average size of establishment*

U K	1935	725 operatives
U S.	1937	1,376 ,,
U S	1939	1,021 ,,

(*b*) *Concentration of employment in the U.S.*, 1939

Size of establishment (no. of operatives)	No. of establishments	% proportion of employment
Up to 100	10	1
101-1,000	27	25
1,001 and over	16	74
Total	53	100

(*c*) *Horse-power per* 100 *operatives**

U S (1939) 1,029 h p.

* 'Power installed' as computed in the U S *Census*

APPENDIX 15

TIN CONTAINERS (TIN CANS)

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The comparison is based on the 'tin boxes and containers' trade in the U K. *Census* (a sub-division of the hardware, hollow-ware, etc. trade), and the 'tin cans and other tin ware' trade of the U S. *Census*.

The comparison is conjectural owing to the fact that U K. output is given in tons only, and the number of tin cans made has therefore to be estimated

II. COMPARATIVE DATA

Table 87. *Output, employment and productivity in the U K and U.S. tin container industries*

(*a*)

	Estimated output*		Estimated no of operatives†	Hours of work
	mill cans	Index§		
U K (1937)	1,700–1,800	100	18,500	48 5‡
U S (1937)	16,200	840	29,650	39 2

(*b*)

	Output per worker		Output per man-hour	Value of net output per head
	'000 cans	Index§	Index§	
U.K (1937)	92–97	100	100	£182
U.S. (1937)	546	525	650	$3,430

* The quantity of 'tin boxes and containers' made in 1935 and 1937 in the U K is available in tons, 161,000 tons and 183,000 tons respectively For 1935 the total amount of tinplate used is also available, amounting to 187,500 tons, while for 1937 it can be estimated at 212,000 tons The International Tin Research and Development Council's *Bulletin* No. 1, p 26, suggests that 100 million cans of the standard size used by fruit and vegetable canners consume about one-quarter of a million base boxes of tinplate, on this basis the lower limit of the total number of cans made can be arrived at. For the U S the number of cans made as well as the amount of tinplate etc used is available (the latter for 1939 only) It amounted to 1,796,000 tons Thus there is a check on the output comparisons by means of the amount of tinplate used; the ratios are not dissimilar It appears, however, that the U.S uses less tinplate per can than the U K, which would not be unexpected considering the much greater amount of automatic equipment used in the former country On this basis the upper limit of the number of cans made in the U K was estimated

† Employment data in both cases are adjusted to discount 'other products of the tin can industry'.

‡ 1935.

§ Weighted-average of three output indexes One is based on physical comparison, the other two by weighting the two main types of cans made, by British and U S average unit values respectively, on the basis of the following data:

III. FACTORS AFFECTING PRODUCTIVITY COMPARISONS

The tin container making industry is a strongly expanding industry both in the U S. and in the U.K.

In the U S. the tin can industry in 1937 had a total sales value (gross output) of 360 million dollars and employed over 33,000 wage-earners. It produced about 11,400 million so-called packers' cans for packing food, about 630 million beer cans and about 4,200 million 'general line' cans, for packing other commodities than foodstuff Packers' cans are quite standardized in size and shape, and hence admirably fitted for mass production General line containers have some standardized shapes and sizes, but also include many thousands of specialty containers for specific purposes Indeed they cover petrol cans as well as beautifully decorated boxes for chocolate. It is in the manufacture of general cans that artistry and design in packaging is demonstrated to the highest degree.* The volume of output had increased by 65% since 1929 and output per head increased during the same period by 64%.†

Although the *Census of Manufactures* registers 224 establishments in 1937, the U S tin can trade is dominated by a few big firms, such as the American Can, Continental Can, and National Can Companies Canned milk producers usually make their own cans, and production is more concentrated in the packers' can business than in the general line can business, where there are more small producers ‡ The leading firm of the trade, the American Can Company, probably produces half of the total output Its sales value amounted to $187 millions in 1937, and it produced about 10,000 million cans

In Great Britain the scale of the tin container making trade is smaller In 1935, the last year for which detailed data are available, the tin box and container trade employed 20,557 persons, and the value of output amounted to £8 millions. The trade was expanding strongly and the value of output from 1907 to 1937 probably trebled, and in the period 1924-35 almost doubled.

	Estimated no		Output value		Unit value per 1,000 cans	
	U K (mill)	U S	U K (mill) £	U.S $	U K £	U S.
Packers' cans	612	12,000	2 7	185	4 35	3 28
All others	1,150	4,200	6 4	136	5 60	71

The result of the physical comparison gives an output index for the U S. of 915 (U K.=100), the use of British average values as weights gives an index of 830; the use of U S average values as weights gives an index of 758.

* See 'Tin Plate and Tin Cans in the United States', *Bulletin of the International Tin Research and Development Council*, No 4, October 1936, pp 82-3

† S Fabricant, *Employment in Manufacturing*, 1899-1939, New York, National Bureau of Economic Research, 1942, p 315

‡ See Temporary National Economic Committee *Hearings*, Part 20, p 10,756 ff and the 1939 *Census of Manufactures*

The increase in output per head in the period 1930-35, the only period for which such estimates can be made, amounted to 8%. For 1937, it can be estimated that 35% (30% by value) of all tin containers produced consisted of tin containers hermetically sealed for canning foodstuffs, 6% (6%) of containers for biscuits and 59% (65%) of containers of other descriptions, such as tobacco, petrol, paint, varnish, etc , as well as highly decorated containers The number of sealed food containers made in 1937 was estimated at 400 millions, but this is probably an underestimate, in any case there has been a vast expansion over the last few decades, since the number made in 1924 was estimated at about 10 millions * This expansion was made possible by the steady and vigorous expansion of the British canning industry,† especially in the canning of vegetables and condensed milk.‡

* See Alexander-Street, *Metals in the Service of Man*, Pelican Books, 1944, p. 143 There was a very substantial increase during the war in the number of containers produced.

† See *A Survey of the Trade in Canned Food*, Imperial Economic Committee, Report 32, London, H M Stationery Office, 1939, and 'The Economics of the Tin Opener' in *The Economist*, 2 July 1938

‡ There was also progress in the canning of fish, fruit, meat, but in these cases the progress was small, and the bulk of home consumption is supplied by imported goods.

Table 88. *Average size of establishment and concentration of employment in the U K. and U S. tin can industries*

(*a*) *Average size of establishments*

U K. (1935)	162
U S. (1939)	128

(*b*) *Concentration of employment**

Size of establishment (no employed)	No. of establishments		Proportion of employment	
	U K. (1935)	U S. (1939)	U.K (1935)	U S (1939)
			%	%
Up to 99 (100)	62	159	13	17
100-499 (101-500)	40	77	46	52
500 and over (501 and over)	11	12	41	31
	113	248	100	100

* For the U.K. all 'employees', for the U S. 'operatives'. U.S size groups in brackets.

APPENDIX 16

GLASS CONTAINERS

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The 'glass container' trade as distinguished in the U.S. *Census* is compared with the 'glass bottles' trade of the U.K., a sub-division of the 'glass trade' in the U.K. *Census*.

II. COMPARATIVE DATA

Table 89. *Output, employment and productivity in the U K and U.S glass container industries*

(*a*) *Output*

	Quantity		Average values	
	U K (1935) (th gross)	U S (1939) (th gross)	U K (1935) (£ per gross)	U S (1939) ($ per gross)
(1) Beer bottles	1,272	2,574	0 705	2 89
(2) Mineral water bottles	409	3,449	0 75	4 12
(3) Others (wine, spirits, etc)	1,035	8,213	0 835	3 60
(4) Milk bottles	688	2,536	0 925	5 16
(5) Chemical and medical bottles	2,707	17,995	0 465	2 12
(6) Perfume bottles	209	—	—	—
(7) Other bottles and jars	4,742	17,768	0 43	3 03
Total average	11,062	52,535	0 551	2 98

(*b*) *Employment*

	U K (1935)	U S (1939)
Total number of employees	17,607	28,670
Number of operatives employed	—	25,753
Estimated number of employees producing output	16,600	28,300
Estimated number of operatives producing output	14,660	25,420
Actual hours of work per week	46 7*	35 2*

* All glass

(*c*) *Comparisons*

	U K. (1935)	U S (1939)
Output (i) Based on unweighted physical output	100	475
(ii) Physical output valued at British prices	100	485
(iii) Physical output valued at U S prices	100	470
All employees	100	170
Operatives	100	173
Output per employee (unit '000 gross)	666	1,856
Output per operative (unit '000 gross)	754	2,067
(i) Based on unweighted physical output	100	274 } 276
(ii) Physical output valued at British prices	100	280 } 276
(iii) Physical output valued at U S prices	100	272 } 276
Output per man-hour	100	366
The value of net output per operative	£260	$3,821

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 90 *Average size of establishment, concentration of employment and horse-power per operative in the U K and U S glass container industries*

(a) *Average size of establishment*

U K (1935)	243 operatives
U S. (1939)	334 ,,

(b) *Concentration of employment*

Size of establishment (number employed)	U K (1935) All glass	U S (1939) All glass	Glass containers	Flat glass	Table ware
	No of establishments				
Up to 99 (up to 100)	231	79	14	10	55
100-499 (101-500)	79	112	47	17	48
500 and over (501 and over)	17	38	16	10	12
Total	327	229	77	37	115

*% proportion of employment**

Size of establishment (number employed)	U K (1935) All glass	U S (1939) All glass	Glass containers	Flat glass	Table ware
	%	%	%	%	%
Up to 99 (up to 100)	18	4	3	2	7
100-499 (101-500)	34	40	45	28	42
500 and over (501 and over)	48	56	52	70	51
Total	100	100	100	100	100

(c) *Horse-power per 100 operatives*†

U K (1930) all glass	225
U S (1939)	545‡

* For the U K all 'employees', for the U S 'operatives'. U S size groups in brackets

† For U K 'power in use' as computed in the U K *Census*, for the U S 'power installed' as computed in the U S *Census*

‡ Flat glass 946 h p ; table ware 240 h p

APPENDIX 17

MOTOR CARS

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The basic problem involved in a valid comparison of productivity between the United Kingdom and United States motor car industries is that the definition of the scope of the two industries should be the same.

Two comparisons can therefore be made. (*a*) of assembly activities only, and (*b*) of activities including the production of an identical range of parts and accessories

We have attempted both types of comparison. For the latter we estimated the number of operatives producing broadly the same range of parts and accessories (e g. tyres have been excluded in both countries). There is no certainty that such an estimate can be satisfactory, based as it is on available information in the *Censuses*, but the error involved on this account is probably not great.

Output was measured in terms of cars made, irrespective of type, quality, or size of the car The data indicate that the ratio of commercial vehicles to private cars is fairly similar in the two countries, and the proportion of other vehicles (e g trailers) is too small to exert any influence on the comparison; therefore adjustment for type appears unnecessary Difference in size and quality of cars is a more serious factor, but it was not possible to make any allowance in this respect. Indication of average sizes of passenger cars and commercial vehicles, given in Tables 105 and 106, shows that while the average U S passenger car is much bigger than the average U K. car, the average U.K. lorry tends to be bigger than the average U.S lorry.

Measuring output in terms of 'cars made', one item of output, namely parts, etc. made for replacement is neglected. An estimate of the relative importance of this item in the total value of output in the two countries has been made, and it was found that on the whole they account for a small proportion of total output, and that they are relatively more important in the U.S ; that is, an 'output of cars per operative' index, which makes no allowance for replacement parts sold separately, is biased in favour of the U.K.

Tables 91-93 give the output and employment data for the U.S. motor car industry, including parts and accessories Tables 94-97 give the same data for the U.K. motor car industry. Table 98 compares output per operative and per man-hour in the two countries, as output is measured in terms of cars, Table 99 indicates the proportion accounted for by the output of replacement parts, which do not enter into the output of finished cars.

Table 100 compares output per head in the U.K. and U.S. motor vehicle assembly trade. Table 101 compares the value of net output per operative in the motor industry.

Tables 102-108 give data relating to factors affecting productivity comparisons

II. COMPARATIVE DATA

Table 91 *Employment in the U S motor car industry*

	1935	1937	1939
(1) Manufacture of complete motor vehicles and chassis	147,044	508,341	397,537
(2) Motor vehicle bodies, parts and accessories	240,757		
(3) Parts and accessories made as secondary products in other industries	15,817	6,500	4,250
(4) Other trades making parts and accessories (not included in (2))			
(*a*) Automotive electrical equipment	17,000	23,000	17,500
(*b*) Batteries	7,500	8,500	7,500
(*c*) Lighting fixtures	5,000	7,000	5,000
(*d*) Flat glass	4,000	5,000	4,000
(*e*) Springs	2,000	3,000	2,000
(*f*) Trailers	1,500	3,000	1,400
(*g*) Automobile stamping	8,000	15,000	8,600
(*h*) Motor vehicle hardware	18,000	21,000	12,000
	466,618	600,341	459,787
(5) Less other products not classified in the industry	18,947	37,024	29,355
(6) Estimated total employment	448,000	563,000	430,000
(7) Actual hours of work	37 1	35 9	35 5

Notes (1) The 1935 data were taken from the 1937 *Biennial Census of Manufactures*, the 1937 and 1939 data were taken from the 1939 *Census of Manufactures*

(2) The estimated employment data in columns (3) and (5) were based on value of gross output per operative, as ascertained from the 1937 *Census* (motor vehicle bodies and motor vehicle parts trade) The 1937 *Census* data have been used in order to avoid inflation in the gross value of output due to duplication in the 1939 *Census*

(3) Rows (4) (*a*)-(*h*) are estimates, most of the categories except (*g*) and (*h*) are parts of a *Census* trade, and the estimated number of operatives approximate

(4) Row (5) For 1935 it has been assumed that all products of the assembly trade not classified in this industry were products of the motor bodies and parts trade, while all products of the motor bodies and parts trade not classified in this trade were regarded as products outside the scope of the motor industry

Table 92. *Output in the U S motor car industry*

(*a*) *Census of Manufactures*

	1935	1937	1939
Motor vehicles and chassis	3,923,052	4,732,553	3,524,831
of which			
Passenger cars including taxicabs	3,211,734	3,849,576	2,824,203
Commercial type vehicles	515,712	614,576	440,762
Ambulances, fire-department apparatus, etc	2,596	4,056	3,795
Passenger chassis	40,596	36,423	21,227
Commercial chassis	152,414	227,922	234,844
(Trailers for motor trucks*)	—	(21,747)	(26,179)
(Automobile trailers*)	—	(24,900)	(16,614)

* Not included with 'motor vehicles and chassis'

(*b*) *U.S. motor vehicle factory sales to domestic and foreign markets*

	1935	1937
Passenger cars	3,252,244	3,915,889
Motor trucks	694,690	893,085
Total motor vehicles	3,946,934	4,808,974

Notes (*a*) 1935 data based on the *Biennial Census of Manufactures*, 1937; 1937 and 1939 data based on the *Census of Manufactures*, 1939

(*b*) Based on *Automobile Facts and Figures* (issued yearly by the Automobile Manufacturers Association, New York), 1939, p 6

'Domestic Markets' represents sales to distributors and dealers in the U S and 'foreign market' includes exports from U S factories plus number of vehicles assembled abroad from parts produced in U S plants

Table 93 *Changes in output, employment, and output per man/man-hour in the U S motor car industry*

(*a*) *Based on Tables* 91 *and* 92

	1935	1937	1939
		Number of cars	
Physical output* per operative	8 76	8 41	8·20
		Index numbers	
Output*	100	121	90
Employment (operatives)	100	126	96
Output per operative	100	96	94
Output per operative man-hour	100	99	98

* Total number of cars made (unweighted).

(*b*) *Based on Bureau of Labor Statistics data*†

	1935	1937	1939
		Index numbers	
Output	100	121	93
Employment (operatives)	100	124	96
Output per operative	100	98	96
Output per operative man-hour	100	101	100

† *Productivity and Unit Labor Cost in Selected Manufacturing Industries* 1919-1940, mimeographed February 1942

Note Indices under (*b*) were recalculated from 1929=100 basis In showing the trend of the changes (*b*) is undoubtedly the more reliable series, as it takes into account all products of the trade while our index is based on the changes in output of the major product only. But the difference between the two series is small

Table 94 *Employment in the British motor car industry*, 1935

Number of persons employed in the manufacture of	
(1) Private cars and chassis	75,567
(2) Commercial vehicles and chassis	20,238
(3) Motor bodies and parts (estimate)	29,000
(4) Other parts and accessories (estimate)	60,000
(5) Total employees	184,805
(6) Less 13 1% on account of clerical staff	24,209
	160,600
(7) Operatives employed by other trades making cars, chassis, parts and accessories	4,400
	165,000
(8) Less operatives producing 'other' output than motor cars	15,000
(9) Estimated total number of operatives, 1935	150,000
(10) Estimated total number of operatives, 1930	125,000-130,000
(11) Estimated total number of operatives, 1924	100,000-105,000
(12) Actual hours of work, 1935	48 0
(13) Actual hours of work, 1924	47·5

Notes (1) Source for rows (1)-(11), *Censuses of Production*, source for rows (12)-(13), Ministry of Labour data

(2) Rows (3), (4), (6), (7) and (8) estimates Rows (3) and (4) were estimated by making allowances for the manufacture of parts and accessories of motor cycles and cycles Row (6) has been estimated on a basis of the ratio of salaried persons to total employment in the motor trade (manufacturing firms) as a whole. Rows (7) and (8) were estimated on basis of gross value of output per operative Row (8), 'other' output—as shown in Table 9 of the *Census* Report, Pt II, p 348—includes a number of engineering products as well as repair work, and the lower gross value of output per operative for repair work has been taken into account

(3) As for 1924 and 1930 the *Census* Reports are much less detailed than for 1935, the estimated number of operatives for these years is only approximate

Table 95. *Comparison of Census of Production output figures with British motor production data of the Society of Motor Manufacturers and Traders (based on registration, exports and imports)*, 1924-35*

(*a*) *Private cars and taxicabs*

	1924	1930	1934	1935
	(1) *Census*			
(1) Private cars and taxicabs	108,311	160,321	246,413	327,152
(2) Complete chassis	9,189	11,826	17,262	22,164
(3) Chassis exported	1,500†	3,984	9,026	10,346
(4) Total home production: (1)+(3)	109,811	164,305	255,439	337,498
(5) Total home production: (1)+(2)	117,500	172,147	253,675	349,316
	(11) S M M T ‡			
(6) Private cars and taxicabs	116,600	169,669	256,866	311,544

* *The Motor Industry of Great Britain* (issued annually), Issue 13, 1938, p 47

† Chassis for private cars and commercial vehicles not shown separately, they were divided arbitrarily in equal proportions between the two categories

‡ S M.M.T. data are for years ended 30 September from 1927 onwards. No allowance is made for variations in stocks, which are thought to be small, or for cars built of imported parts (also insignificant)

(*b*) *Commercial vehicles, including omnibuses*

	1924	1930	1934	1935
	(1) *Census*			
(1) Commercial vehicles (other than taxicabs, tricars and tractors)	25,062	40,253	46,845	50,409
(2) Complete chassis	13,262	28,519	39,692	41,533
(3) Complete chassis exported	1,405	3,057	11,372	11,380
(4) Total home production (1)+(3)	26,467	43,310	58,217	61,789
(5) Total home production (1)+(2)	38,324	68,772	86,537	91,942
(6) (Trailers (not included in above))	n a	n a	n a	(5,267)
	(11) S M M T *			
(7) Commercial vehicles including omnibuses	30,000	66,859	85,633	92,176

* See footnote ‡ above. n a.=not available

Table 96. *Output in the British motor car industry*

	1924	1930	1935
(1) Private cars and taxicabs (Column 4 of Table 95 (*a*)	109,811	164,305	337,498
(2) Commercial vehicles (Column 5 of Table 95 (*b*)	38,324	68,772	91,942
(3) Total motor cars and chassis made	148,135	233,077	429,440
(4) Margin of error +	7,689	7,842	11,818
(5) —	11,857	25,462	30,153
(6) Total motor cars and chassis made (possible limits)	136,000-156,000	208,000-241,000	399,000-441,000

Table 97. *Changes in output, employment and output per man man-hour in the U K motor car industry*

(*a*) *Motor car industry*

(Based on Tables 94-96)

	1924	1930	1935
Physical output per operative*	1 33-1 52	1 63-1 89	2 66-2 94
Output*	35	54	100
Employment (operatives)	67-70	83-87	100
Output per operative	51	64	100
Output per operative man-hour	52	—	100

* Number of cars made, unweighted

(*b*) *Motor and cycle industry*

(Based on Tables VII and XI of the *Census*)

	1924	1930	1935
Output	42	61	100
Employment	76	86	100
Output per operative	55	71	100

Note The two tables are not comparable, as (*b*) includes the motor cycle and cycle trades as well The trend of development is the same in both cases, although (*a*) perhaps slightly exaggerates the rate of increase

Table 98 *Comparison of productivity in the U K. and U S. motor car industries**

	Cars per operative	Index
U K output per head 1935	2 86	100
U S ,, ,, ,, ,,	8 76	306
U K ,, ,, man-hour 1935	—	100
U S. ,, ,, ,, ,,	—	396

* Number of cars made, unweighted

Table 99. *The allocation of the value of gross output without duplication among the different products in the U K. and U S. motor car industries*

(*a*) *U K.* 1935

The estimated value of gross output of motor cars with duplication		£120 millions
The estimated value of gross output of motor cars without duplication		£76—80 millions
Value of output of private cars	£48 4 millions	
Commercial vehicles	£10 1 „	
Value of exports of chassis for private cars and commercial vehicles	£ 2·7 „	
Value of chassis for commercial vehicles not exported	£ 8 2 „	
Trailers	£ 0 6 „	
	£70 0 „	
Replacement parts etc.	£6—£10 „	
		£76—80 millions

(*b*) *U S*

	1935 $ (millions)	1937 $ (millions)	1939 $ (millions)
Value of output of motor vehicles and chassis	$2,153·0	$2,849	$2,275
Parts and accessories sold at home, wholesale value (liable to Federal Excise Tax)	$359·0	$474 5	
(Parts and accessories exported including parts for assembly)	($65 0)	($93)	

Notes As the British *Census of Production* gives an estimate of the value of gross output without duplication for the motor and cycle industry as a whole, the value of output without duplication of the motor industry can be estimated The difference between this estimate and the value of the other products of the trade can be regarded as accounted for by the production of spare parts, etc There are no direct estimates available on the value of the spare parts, etc produced, but export statistics would indicate that about 19% of the total value of exports in 1935, and 17% in 1937, were accounted for by exports of spare parts, etc. ('Parts for assembly' exported were not included in spare parts) For the U S the value of gross output without duplication of the motor trade is not available On the other hand there are two direct estimates available on the value of parts, accessories, etc produced The one given above is based on the Federal Excise Tax receipts, and is quoted from *Automobile Facts and Figures*, 1939, pp 14, 55 To the extent that it refers to wholesale value and not to factory value, this figure is over-estimated On the other hand the Federal Excise Tax does not apply to parts and accessories exported, direct sales to Governments, and items which are used for a variety of purposes other than automotive For 1938 *Automobile Facts and Figures* gives another estimate of the wholesale value of replacement parts and accessories, based on figures from the Motor and Equipment Manufacturers Association

Replacement parts and accessories	$506 6 millions
Parts sold by motor vehicle manufacturers	$258 8 „
	$765·4 millions

as against an estimated wholesale value of $354 millions based on excise statistics for 1938 Even if we allow for the fact that in the U S 'accessories' are widely interpreted and may include wireless sets, etc installed in the car after purchase, it appears that the estimate based on Federal Excise statistics is an under-estimate.

Another way of estimating the potential ratio of production of finished cars to spare parts, etc. can be arrived at by relating the total number of cars on the road to the yearly output of new cars For this purpose we have added to the number of cars registered at home the cars exported in the course of the last eight years—the average life of a car—as these cars require replacement parts from the producing country, while imported cars were deducted In Britain the ratio of British-made cars estimated to be on the roads to newly-produced cars was 6 1 for both 1935 and 1937, in the U S the ratio of U S -made cars estimated to be on the roads to newly-made cars was about 7 1 for both 1935 and 1937

Table 100 *Comparison of output per head in the U.K. and U.S. motor vehicles assembly trades*

(a) U K, 1935

(1) Estimated number of operatives employed in assembly	71,300
(2) Estimated number of vehicles made (including chassis)	429,440
(3) Estimated number of vehicles assembled per operative	6 02

(b) U S

(4) Estimated number of operatives employed in assembly	1935	132,400
	1937	179,000
(5) Estimated number of vehicles made (including chassis)	1935	3,923,052
	1937	4,732,553
(6) Estimated number of vehicles assembled per operative	1935	29 63
	1937	26 44

(c) U.K.-U S. comparison

U K,	1935	=100
U S,	1935	492
	1937	439

Table 101. *The value of net output per operative in the U K and U S. motor car industries*

(a) U K. and U S data

U K, 1935 motor vehicles trade (estimate)	£288 5
U.K, 1935 motor and cycle trade	£284·4
U S, 1935 motor vehicles trade	$2,893
U S, 1937 ,, ,, ,,	$3,094
U S, 1939 ,, ,, ,,	$3,313

(b) U K and U S. expressed in £

Official rate of conversion

1935 £=$4 90
1937 £=$4 94
1939 £=$4 44

Net output per head

U K	(1935)	£288 5
U S	(1935)	£590 0
	(1937)	£626 0
	(1939)	£746 0

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 102 *Average size of establishments*

(a) Employees per establishment

	No of establishments	No. of operatives	No of operatives per establishment
U K (1935)			
Assembly of private motor cars, commercial vehicles and chassis	106	83,255	785
Total motor and cycle industry	835	194,960	233
U S ·			
Assembly of motor vehicles			
1935	121	147,044	1,215
1937	131	194,527	1,485
Total motor and cycle industry.			
1935	969	392,894	405
1937	1,096	486,279	444
1939	1,169	405,936	347

Table 102. (*b*) *Output of motor vehicles per establishment*

	Output of motor vehicles (excluding chassis, motor cycles and cycles)	Output per establishment
U K (1935)	378,000	495*
U S (1935)	3,730,000	3,942
(1937)	4,471,000	4,539
(1939)	3,269,000	3,102

* This is an underestimate both on account of inclusion of establishments making parts, etc for cycles and motor cycles as well as on account of exclusion of chassis from final products

Table 103. *Concentration in the U K. and U.S motor industries*
(motor and cycle trade)

	U K (1935)				U S (1939)*				
Establishments with more than *x* employees	No of establishments	No of employees	% proportion of establishments with more than *x* employees	% proportion of employees (cumulative)	% proportion of workers (cumulative)	% proportion of establishments with more than *x* workers	No of establishments	No of workers	Establishments with more than *x* workers
			%	%	%	%			
					100 0	100 0	1,343	432,028	0
10	835	224,568	100·0	100 0					
					98 8	50·1	673	426,899	20
24	608	220,600	72 8	98·2					
49	414	213,741	49 6	95 2	97 4	36 4	489	420,768	50
99	270	203,535	32 3	90 6	95 6	28 3	380	412,966	100
199	166	188,886	19 9	84·1					
					91 1	19 0	255	393,626	250
299	131	180,530	15 7	80 4					
399	100	169,972	12·0	75 7					
499	82	161,813	9·8	72 1	85 1	13 7	184	367,581	500
749	50	141,830	6 0	63 2					
999	36	129,596	4 3	57 7	73 2	8 2	110	316,006	1,000
1,499	26	117,761	3 1	52 4					
					46 6	2 3	31	201,118	2,500

* Including the automobile trailer, automobile stamping and automobile electrical equipment trades

Table 104. *Product structure of the U.K. and U.S. motor car industries*

Out of every 100 cars and chassis built
in the U.K. (1935)—21 were commercial vehicles
in the U.S. (1935)—17 ,, ,, ,,
(1937)—18 ,, ,, ,,
(1939)—19 ,, ,, ,,

For every 100 passenger cars there were
in the U.K. (1935)—0.2 buses and 1·6 trailers
in the U.S. (1937)—0.2 ,, ,, 1·2 ,,

Note. Based on the assumption that all chassis built in Britain were added to the total commercial vehicles made. (See Tables 95 and 96.)

Table 105. *Data relating to the degree of standardization in the U.K. and U.S. motor car industries*

(a) U.S.

	Number of cars sold	
	1937	1939
(1) Total sales of all cars in the U.S.	3,483,752	2,653,377
(2) Total sales of three leading models	1,996,040	1,429,137
(i) Chevrolet, made by General Motors	768,040	598,834
(ii) Ford, made by Ford	766,000	481,496
(iii) Plymouth, made by Chrysler	462,000	348,807
(3) Total sales of three leading models % of total sales of all cars	57%	54%

(b) U.K.

	No. of cars sold in the year ending September 1939	
(1) Total sales of all cars in the U.K.		303,000
(2) Total sales of the two leading types by all makers 8 h.p. models	103,190	
10 ,, ,,	101,580	
(3) Total sales of the three leading makers of		
(i) 8 h.p. models	81,000	
(ii) 10 ,, ,,	61,000	142,000
(4) Total sales of six leading models as % of total sales of all cars		47%

Table 106. *Average size of private cars in the U.K. and U.S.*

(a) U.K.

	1935 (h.p.)	1937 (h.p.)
(i) Estimated average class of vehicle in use	12.1	11.9
Estimated average class of new registration	11.8	12.0
(ii) Private cars made in 1935 (excluding chassis or taxis)	326,755	
No. of these not exceeding 12 h.p.	257,551	
in %	78.7	

(b) U.S.

Estimated average size of cars, in 1937—30 h.p.

Note. No direct estimates are available, but the leading models (such as Chevrolet, Ford and Plymouth) were of 30 h.p. in this year.

Table 107. *Average size of commercial vehicles in the U K and U.S.*

	U K. (1935)				U S.		
(1)	(2) U K registration in the year ending Sept 1936	(3) Goods vehicles	(4) Chassis for goods vehicles	(5) Goods vehicles and chassis	(1935) (6) Trucks	(1937) (7) Trucks	(8)
	%	%	%	%	%	%	
(1) Capacity not exceeding 15 cwt. (¾ ton)	44·0	56·9	11·5	37·3	40·0	50·7	(1) Light delivery (less than 1 ton)
(2) Capacity exceeding 15 cwt and not exceeding 30 cwt. (¾ ton-1½ ton)		14·0	17·2	15·4	53·1	40·7	(2) 1-1½ tons, inclusive
(3) Capacity exceeding 30 cwt not exceeding 50 cwt. (1½-2½ tons)	47·0	16·2	35·1	24·4	—	—	(3) —
(4) Capacity exceeding 50 cwts (over 2½ tons)	9·0	12·9	36·2	22·9	—	—	(4) —
(5) — —	—	—	—	—	6·4	7·3	(5) 2-4½ tons, inclusive
(6) — —	—	—	—	—	0·5	1·3	(6) 5 tons and over
(7) Total %	100·0	100·0	100·0	100·0	100·0	100·0	(7) Total %
(8) Total number	76,657	48,559	36,866	85,425	505,226	602,144	(8) Total number

Sources. Column (2) *The Motor Industry of Great Britain*, op cit Columns (3), (5) *Census of Production* Columns (6), (7) *Automobile Facts and Figures*, op cit

The three leading companies in the U.S., General Motors, Ford and Chrysler produced 89% of all the cars made in 1939. In the U.K. the three leading makers, the Nuffield Organization, Austin and Ford produced about two-thirds of the output, while eight makers produced about 88% of the total The three American leading companies made ten leading brands of private cars and these accounted for 88% of sales For these ten brands the companies produced fifteen engine types in all. In Britain the eight leading makers who also accounted for 88% of sales produced thirty-nine different engine types as compared with the U.S figure of fifteen.

Table 108. *Horse-power per 100 operatives in the U.K. and U.S. motor car industries**

U K (1930)	121 h p †
U S (1939)	
Motor vehicles etc	565 ,,
Motor cycles etc	302 ,,

* For the U K 'power in use' as computed by the U K. *Census*, for the U S 'power installed' as computed by the U S *Census*

† Motor and cycle trade.

APPENDIX 18

RADIO

I. SPECIFIC FACTORS AFFECTING PRODUCTIVITY COMPARISONS

There are two main factors.

(i) The average article made in each country is not comparable, as a large part of the U.S. output consists of midget sets, which have no counterpart in the U K. industry. Moreover, U.S. valves are of a simpler design and U S. output therefore has to be adjusted accordingly.

(ii) The range of products and processes is not identical in the two countries, as shown by the *Census* Reports. The U S. *Census* treats 'radios, radio tubes and phonographs' as one industry. In other words, it includes radio tubes sold to wireless set makers, and there is thus a measure of duplication in gross output. It also includes phonographs (i e the gramophone industry, including records and needles) On the other hand it excludes the manufacture of radio apparatus parts, such as transformers, batteries, coils, condensers, etc., most of which are included in a separate group called 'communication equipment'

The British *Census*, on the other hand, treats 'wireless apparatus (except valves)' as a separate industry, a sub-group of the electrical engineering industry, which includes assembly and the making of some of the accessories, 'wireless valves and electric lamps' are another sub-group of the electrical engineering industry.

In order to compare the two industries, a number of estimates have to be made as to the degree of duplication in the value of gross output as well as the number of persons employed in those parts of the respective industries which are beyond the scope of this comparison, i e the gramophone industry in the U.S. and the electric lamps industry in the U.K It will also be necessary to include a small amount of radio products made in other *Census* industries. Even after these allowances have been made, the assumption that the same proportion of some parts (e.g. cabinets) is manufactured within each industry will be necessary

II. COMPARATIVE DATA

The *basic data* with the necessary adjustments are set out below:

Table 109. *Output and employment in the U.K. and U.S. radio industries*

(*a*) *U.K. radio industry* 1935

(i) Output

	£ millions	% of £ value	Quantity (in th.)
Gross output of firms included in the wireless (except valves) industry	14·9	—	—
Deduct output of other products, not radio	1·2	—	—
Output of radio apparatus in the wireless apparatus trade	13·7	—	—
Add output of radio valves in wireless valves and electric lamps industry	1·9	—	—
	15·6		
Deduct duplication estimated at (i) for valves £·87 mill. (ii) for components £1·5 "	2·37	—	—
Total value of output without duplication	£13·2		
Types of product.			
Radio sets	9·6	72·6	1,567
Radiograms	1·6	11·8	104
Transmitter and television apparatus	·4	3·1	—
Valves for replacement	1·0	8·0	3,604
Component parts, loudspeakers and other radio products	·6	4·5	—
Total radio apparatus	£13·2	100·0	

(ii) Employment

Total number of employees in firms of the wireless apparatus (except valves) industry	32,141
Deduct estimated number producing output not classified in the radio industry	2,900
	29,241
Add estimated number making valves in the wireless valves and electric lamps industry	4,250
Estimated total number of persons engaged in producing the above output	33,491
Estimated number of operatives*	28,500

* 85% of the total number of employees. Ratio ascertained for firms in the radio industry.

Table 109 (*b*) *U S radio industry* 1939

(i) Output

	\$ millions	% of \$ value	Quantity (in th)
Gross output of firms classified in the radio, radio tubes and phonograph industry	275 9		
Deduct output of phonographs, records and other phonographic products	49 5		
Deduct output of products of other industries made in the radio industry	11·8		
Output of radio apparatus in the radio, radio tubes and phonograph industry	214 6		
Add output of radio parts by firms in communication equipment industry	44 2		
	258 8		
Deduct duplication estimated at (i) for valves \$23 millions (ii) for components sold to set-makers \$40 ,,	63·0		
Total value of gross output without duplication	\$195 8		
Type of product			
Radio sets	132·8	67 8	9,417
Radiograms	13·7	7 0	380
Transmitting and television apparatus	5·1	2 6	—
Valves for replacement	10 7	5 5	31,477
Component parts, loudspeakers and other radio products	33 5	17·1	—
Total radio apparatus	\$195·8	100 0	

(ii) Employment

Total number of employees in firms of the radio, radio tubes and phonographs industry	55,924
Deduct estimated number making phonographs, and other products not counted as radio output	13,400
Add estimated number making components in the communication equipment industry	10,300
Estimated total number of persons engaged in making the above output	52,824
Estimated number of operatives (say 84%)	44,300

Comparisons

The three main items of physical output which account for 92 4% of U.K. output and 80 3 of U S. output show the following ratios

	U K	U S.
Radio sets	100	601
Radiogramophones	100	365
Valves for replacement	100	873

In order to express the ratio of total output in the two countries in one figure, it will be necessary to convert the different items of output into one unit on the basis of their unit values.

The following relative unit values can be computed from the data.

	Average unit values		Implied rate of exchange
	U K (1935)	U S (1939)	
Wireless sets	£6 156	$14 102	2 29
Radiogramophones	£15 087	$36 053	2 39
Valves	£0 295	$0 340	1 15

It can be seen that the implied rate of exchange is much lower than the general rate of exchange, suggesting either that radio products are cheaper in the U S. and/or that the average articles are not comparable In the case of the radio industry both factors apply. Trade sources indicate that the comparative price of a broadly identical table receiver was $35 in the U.S. in 1939, and £12 12s. in the U K in 1935, for consoles the comparison would be one of $50 with £18 18s These comparisons indicate exchange rates in terms of radio products of $2 80 and $2 65 to the £, or an average of $2 75. For valves no direct comparison is available, but $2 75 is probably a likely exchange rate for both valves and all other radio products By accepting this exchange rate instead of the implied exchange rate as shown above (i.e. $2 75 instead of $2 29 for sets and $2 75 instead of 1·15 for valves), the assumption is made that the average U S set is about one-sixth lower in quality and the average U S. valve about one-third lower in quality than the U.K. product. This is not unreasonable, as it is known that the U.S. output contains a high proportion of midget sets and that the U S valve is of a simpler construction and more valves are needed per unit as initial equipment

By converting U S. unit values by the ascertained exchange rate applicable to the wireless industry into £'s and applying the same exchange rate to that part of the U S output for which value data are available, we get the following comparison of output in terms of comparable products

Table 110 *Output, employment and productivity of comparable products in the U K. and U S radio industries*

	U K (1935)	U S (1939)*	U S as % of U.K
Output			
Radio sets and radiograms (£millions)	11 2	53 3	476
Other radio apparatus ,,	2 1	17 9	852
Total ,,	13 2	71 2	539
Employment and hours			
Number of persons employed	33,491	52,824	158
Number of operatives employed	28,500	44,300	155
Average hours worked per week	46	38 5	84
Productivity	Index numbers		
Output per employee	100	341	
Output per operative	100	348	
Output per man-hour (operative)	100	414	
Value of net output per operative			
Wireless and lamps†	£271	$3,506	
Wireless apparatus only (radios, radio tubes, etc for the U S)	£249	$2,988	

* There was a substantial increase in U S output per man-hour between 1935 and 1939 mainly associated with increase in output

† Based on net output in the 'wireless apparatus' and 'wireless valves and electric lamps' industry in Britain and the 'radios, radio tubes and phonographs' and 'electric lamps' industry in the U S Operatives for Britain have been estimated as before as 85% of all employees.

III. FACTORS AFFECTING PRODUCTIVITY COMPARISONS

The following two tables give an indication of the average size of establishment and concentration of establishments in the wireless industries of the two countries

Table III. *Average size of establishment and concentration of employment in the U K and U S. radio industries*

(*a*) *Average size of establishment*

	No of operatives
U K (1935):	
Wireless apparatus	294
Wireless valves and electric lamps	196
U S (1939)	
Radio, radio tubes and phonographs	194
Electric lamps	175

(*b*) *Concentration of employment**

Size of establishment (no. employed)	No of establishments				% proportion of employment				Size of establishment (no employed)
	U K wireless	U K valves	U S radio	U S electric lamps	U K wireless %	U K valves %	U S radio %	U S electric lamps %	
Up to 99	55	25	164	32	6	12	7	12	Up to 100
100-999	30	12	52	22	28	34	48	88	101-1,000
1,000 and over	8	5†	8	1	66	54†	45	—	1,001 and over
Total	93	42	224	55	100	100	100	100	Total

* For the U K all 'employees', for the U S 'operatives'.
† 750 and over.

APPENDIX 19

ELECTRIC LAMPS

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

A comparison of the industry in the two countries can only be approximate, as the U K. *Census* treats wireless valves and electric lamps as a single group. In order to compare output per operative in the two countries, an estimate of the number of operatives engaged on the production of electric lamps only has to be made, and this is necessarily rough. Moreover, the number of administrative and clerical staff, which is not shown separately, has to be estimated and deducted from the total number of employees.

The 'electric lamp' industry of the U S. *Census of Manufactures* is compared with the 'wireless valves and electric lamps' industry of the U.K. *Census of Production*, a sub-group of the 'electrical engineering' industry. Bulbs made in other industries were included.

II. COMPARATIVE DATA

Table 112 *Output, employment and productivity in the U.K and U.S electric lamp industries*

	U K (1935)	U S (1939)	Ratio U K = 100
Output			
Bulbs 20 volts and over (in number of millions)	81 2	516 7	636
Value in millions	£3 1	$58 4	
Bulbs for motor vehicles (in number of millions)	12 5	136·6	1,090
Value in millions	£0 3	$7 2	
Weighted output *			
U K weights	100	674	
U S weights	100	663	
Employment			
Estimated number of operatives †	6,000	7,400	123
Output per operative index	100	539-548	
Output per operative (in th bulbs) ‡	15	79	

* Based on re-weighting by average values in Britain and U S

† Based on the ratio of the value of the selected products to the value of gross output of the whole trade

‡ Two motor vehicle bulbs were taken as equal to one ordinary bulb

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 113. *Average size of establishment and concentration of employment in the U.K. and U S. electric lamp industries*

(a) *Average size of establishments*

U K (1935) 196 operatives*

U S (1939) 175 „

* Wireless valves and electric lamps

Table 113. (*b*) *Concentration of employment*

Size of establishment (number employed)*	No of establishments		Proportion of employment	
	U K (1935)†	U S (1939)	U K (1935)†	U S. (1939)
			%	%
Up to 99 (up to 100)	25	32	12	12
100 and over (101 and over)	17	23	88	88
Total	42	55	100	100

* For the U K all 'employees', for the U S 'operatives', U S size groups in brackets
† Wireless valves and electric lamps

APPENDIX 20

BOOTS AND SHOES

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The 'boot and shoe trade' of the United Kingdom *Census of Production* (excluding repair firms) is compared with the United States 'footwear (except rubber)' trade. Rubber shoes are excluded from the comparison.

The American practice is that cut soles and insoles as well as such other components as leather heels and moulded stiffeners are made by specialist firms and bought by the footwear firms from them. Consequently the U.S. *Census* treats 'boot and shoe cut stock and findings' as a separate trade. Thus when comparing employment in the two countries, the labour force in the U.S. boot and shoe cut stock and findings trade has been added to the labour force of the footwear trade.

II. COMPARATIVE DATA

Table 114. *Output in the U.K. and U.S. boot and shoe industries*

	Output (thousand pairs)					
		U.S.			Product structure	
	Britain (1935)	1935	1937	1939	Britain (1935)	U.S. (1937)
					%	%
Men's	30,912	96,650	104,129	104,762	23·4	24·5
Women's	46,728	146,287	150,900	168,777	35·4	35·5
Youths' and boys'	7,908	18,500	19,127	17,316		
Girls' and maids'	13,500	43,521	43,382	46,091	23·0	20·2
Infants'	9,060		23,357	24,632		
All other types	24,360	83,534	84,076	73,681	18·2	19·8
Total	132,468	388,492	424,971	435,259	100	100

Table 115. *Prices (average values per unit of output) in the U.K. and U.S. boot and shoe industries*

	Prices per dozen pairs				Ratio of prices of men's shoes to other shoes			
	Britain (1935) £	U S (1935) $	U S (1937) $	U S (1939) $	Britain (1935)	U S (1935)	U S (1937)	U S (1939)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Men's	5 03	26 04	29 04	26 40	100	100	100	100
Women's	4 24	23 04	25 44	23 88	84	88	88	91
Youths' and boys'	2 60	18 12	18 72	17 16	52	70	64	66
Girls' and maids'	2 12	13·08	13 80	13 08	42	50	48	50
Infants'	1 10	10 80 (Infants' and All other types together)	9 12	8 64	22	41 (Infants' and All other types together)	31	33
All other types	1 66		13 92	11 88	33		48	45
Average	3·41	19 80	21 60	20 16				

Table 116 *Employment in the U K and U S boot and shoe industries*

(*a*)

	Value of gross output in the footwear trade	No of operatives in the footwear trade	Quantity of shoes produced	Value of all shoes produced	Correction factor (4) (1)	Estimated operatives producing shoes (2)×(5)	Actual average hours of work per week
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	£ or $ th		th pairs	£ or $ th			
Britain (1935)	40 180	108,649	132,468	37,619	93 6	101,695	47 2*
U S (1935)	643,872	202,113	388,492	641,464	99 6	201,304	35 5†
(1937)	768,327	215,438	424,971	765,412	99 62	214,619	36 1†
(1939)	734,673	218,028	435,259	731,816‡	99 61	217,178	35 7†

* Average hours actually worked in the week which ended 12 October 1935 (Ministry of Labour)
† Bureau of Labor Statistics data
‡ Ignoring the small amount of cut stock and findings made in the trade—not shown for previous years

(*b*) *Boot and shoe cut stock and findings*

U S	Value of gross output of trade (1)	No of operatives in trade (2)	Value of all cut stock and findings produced in trade (3)	Correction factor (3) (1) (4)	Estimated operatives producing cut stock and findings (5)
	($ th)		($ th)		
1935	111,579	18,275	95,720	85 79	15,678
1937	132,660	18,755	120,257	90 65	17,001
1939	129,399	18,845	124,642	96 32	18,152

Table 117. *Productivity in the U K. and U S. boot and shoe industries*

Country	Year	Method of weighting*	Men's shoes equivalent of all shoes produced	Estimated number of operatives: producing boots and shoes	Estimated number of operatives: producing cut stock & findings	Estimated number of operatives: Total	Output of men's shoes per operative		Estimated number of man-hours used in shoe production	Output of men's shoes per man-hour	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
			(Th pairs)				(Pairs)	(Index)	(Weekly)	(Pairs)	(Index)
U K.	1935	1935 U S relative prices	98,021			101,695	964	100	4,800,000	0 393	100
U S	1935	(Col 6 of Table 115)	294,342	201,304	15,678	216,982	1,357	141	7,702,861 †	0 735	187
U K	1935	1935 British prices	89,978			101,695	885	100	4,800,000	0 361	100
U S	1937	(Col 5 of Table 115)	291,935	214,619	17,001	231,620	1,260	142	8,361,482 †	0 671	186
U K	1935	1937 U S prices	98,155			101,695	965	100	4,800,000	0 393	100
U S	1937	(Col 7 of Table 115)	317,774	214,619	17,001	231,620	1,372	142	8,361,482 †	0 731	186
U K	1935	1939 U S prices	99,355			101,695	977	100	4,800,000	0 398	100
U S	1939	(Col 8 of Table 115)	334,109	217,178	18,152	235,330	1,420	145	8,401,281 †	0 765	192

* Women's shoes etc have been expressed in terms of men's shoes according to the ratio of prices as shown in Table 115 In all cases identical weights (price-ratios) have been applied to the data of both countries. For 1937 both British and U S price-ratios have been applied alternatively to indicate that differences remain largely unaffected whether we apply British or U S weights

† Average hours per week in the U S cut stock and findings trade assumed to be the same as in the U S footwear trade.

Table 118 *The value of net output per head in different-sized establishments in the U K and U S boot and shoe industries**

Establishments having employees	Net output per employee U K (1935) £	Net output per operative U S (1939) $	U K (1935)	U S (1939)
			Average=100	
Up to 99 (100)	158	1,440	98	91
100-499 (101-500)	160	1,582	99	100
500-999 (500-1,000)	170	1,593	105	100
1000 (1001) and over	162	1,743	100	110
Average	162	1,588	100	100

* For U K 'employees', for U S 'operatives', U S size groups in brackets

Table 119 *Changes in productivity in the U K and U S boot and shoe industries*

(*a*) *Long-term changes in productivity of labour*, 1907-39

	Output per man-hour		Horse-power per 100 operatives‡	
	U K.*	U S †	U K	U S
1907	65		18	-
1909		57		
1924	82		46	
1925		63		
1929		78		68
1930				
1935	100	100	48	
1937		100		
1939		104		68

* This index is based on changes in the total number of shoes etc made, irrespective of kind (men's, women's etc) and quality, and should be regarded as a broad indication of trends The following actual hours of work were taken 1907, 53, 1924, 46 3, 1935, 47 2.

† Based on indices of the National Bureau of Economic Research, New York, as computed by S Fabricant *Employment in Manufacturing*, 1899-1939, New York, 1942

‡ Based on *Censuses of Production* The aggregate of horse-power of prime movers and electric motors driven by purchased electricity, divided by the number of operatives

(*b*) *Changes in output, employment and productivity*, 1924-44

Year	U K. Output	U K. Employment	U K. Output per wage-earner	U K. Output per man-hour	U S Output	U S Employment	U S Output per wage-earner	U S Output per man-hour
		Index 1935=100				Index 1935=100		
1924	82	106	77	78	80	102	78	66
1930	85	99	86	—	81	95	85	78
1935	100	100	100	100	100	100	100	100
1937	—	—	—	—	107	107	100	99
1938	—	—	—	—	102	104	98	102
1939	—	—	—	—	112	108	104	103
1940	—	—	—	—	107	102	105	109
1941	—	—	—	—	133	107	124	117
1942	—	—	—	—	130	105	124	115
1943	—	—	—	—	117	92	126	115
1944	—	—	—	—	106	86	123	108

Sources U K: Calculations based on *Census* material, etc.; U.S. Bureau of Labor Statistics data.

III. FACTORS AFFECTING PRODUCTIVITY COMPARISONS

(*a*) The trade association of the boot and shoe manufacturers sent a mission to the United States in the spring of 1945 The report of the mission* largely confirms the factual findings as shown in section II; it states that 'the productivity per productive worker-hour in United States factories is, on the average, as much as three-quarters as high again as in United Kingdom factories'.

In their opinion, derived from the facts examined by them and from their observations, the greater productivity of the U S industry is due, among various other reasons, to

(i) the larger size of the average factory,
(ii) specialization in the type of goods produced,
(iii) consequently longer runs of orders,
(iv) proportionately fewer lasts and patterns, and greater familiarity of operatives with the work,
(v) also less paper work at the factory, and
(vi) much higher proportion of piece-work,
(vii) centralized or more intensified planning and preparation of work,
(viii) greater attention paid to the elimination of unnecessary movements by the operator,
(ix) easier transit of work through the factory.

(*b*) Another independent study into relative productivity in the British and American boot and shoe industry has been undertaken by Mr R F. Ledger, an expert of the industry with practical experience both in Britain and in America † This comparison is confined to ladies' shoes, comparing a broadly similar grade of products in both countries (assuming that goods selling in the same price field are similar in quality) This estimate is based on a very small sample, and the author says that the British firms chosen for the comparison are the most progressive and efficient manufacturers.

On the basis of Mr. Ledger's data, taking into account the importance of the several footwear making departments, the following differences can be computed. Taking output per worker in the U K as being equal to 100, output per worker in the U S. for highly priced ladies' shoes can be put at 160, for the medium-price range at 128, and for the low-price range at 111 Mr Ledger does not endeavour to give a full explanation of the differences, but he refers to a number of factors accounting for them· (i) Differences in equipment used, especially in the clicking (cutting) and closing department of the shoe room, (ii) a greater degree of specialization in the U S, (iii) quality differences (more careful finishing done in Britain); (iv) higher amount of piece-work in the U.S , (v) attitude of the worker.

* *The Boot and Shoe Industry*, a report by Mr Denton and Mr Colvin upon their visit to the U S A, spring 1945 The Incorporated Federated Associations of Boot and Shoe Manufacturers of Great Britain and Ireland

† R F Ledger, 'An Investigation into Comparative per-Man-hour Productivity in the Manufacture of Ladies' Shoes in Britain and America', *The National Institution of Boot and Shoe Industry Journal*, December 1947, pp 460-78.

(*c*) Changes in productivity of labour.

Changes in the productivity of labour in the boot and shoe industry in the period 1923-36 have been the subject of an analysis by the U.S Bureau of Labor Statistics * They have been at a somewhat quicker pace in the U.S. than in the U.K.

The main factors affecting labour productivity, according to this study, were as follows·

Shoe machinery. The view is put forward that machinery as such has played a small role in the last ten to fifteen years (prior to 1936) in decreasing the labour time required to produce a pair of shoes, but it has played a considerable role in making possible basic style changes

Engineering studies show that machinery alone—irrespective of all other factors—increased labour productivity in making comparable men's shoes by about 61% between 1900 and 1923 and by a further 15% between 1923 and 1936 At the same time the *actual* increase in the period 1923-36 has been for men's shoes between 38% and 51% These figures indicate that the major changes in machinery occurred prior to 1923, and that after 1923 other factors than improvement of machinery were operating in increasing productivity.

Style factor. The increasing complexity of detail in women's shoes and the effect of style in general—a factor weakening standardization—slowed down or even decreased labour productivity Much of this reduction however, has been counterbalanced by the elimination of other operations and by the introduction of machinery to replace hand work in the newer fields.

Management. In addition to the general changes in shoe machinery, which under the lease system affected all manufacturers of shoes, a number of plants have been installing special devices to reduce further the amount of hand labour needed in the process of manufacture, for example various types of conveyors, etc.

The report points out that the utilization of the same or approximately the same machinery in the shoe industry—due to the lease system—does not preclude large variations in the output of these machines arising from variations in management efficiency or in the skill of individual operators. Further not all plants can afford to hire all machinery, and specialized types of machinery are economical only when there is a large output of shoes

A sample survey of the Bureau of Labor Statistics found extremely wide variations in output per man-hour within each main category (men's, women's) due to a number of factors

(*d*) *Tables relating to factors affecting productivity comparisons*

Table 120 *Average size of establishment, concentration of employment, and horse-power per operative in the U K and U S boot and shoe industries*

(*a*) *Average size of establishments*

U K	(1935)	134 operatives
U S	(1935)	197 ,,
	(1937)	199 ,,
	(1939)	204 ,,

Source *Census of Production* and *Census of Manufactures*

* *Monthly Labor Review*, February 1939

Table 120 (*b*) *Concentration of employment*

U K (1935)					U S (1939)				
Establishments with more than *x* employees	No of establishments	No of employees	% proportion of establishments (cumulative)	% proportion of employees (cumulative)	% proportion of establishments (cumulative)	% proportion of workers (cumulative)	No of establishments	No of workers	Establishments with more than *x* workers
			%	%	%	%			
10	808	116,567	100 0	100 0	100 0	100 0	1,070	218,028	0
					82 5	99 2	883	216,319	20
24	648	114,086	80 2	97 9					
49	503	108,445	62 2	93 0	68 7	97 0	735	211,401	50
99	310	94,683	38 4	81 2	55 3	92 2	592	201,025	100
199	163	73,890	20 2	63 4					
					29 3	70 8	314	154,410	250
299	99	58,571	12 3	50 2					
399	64	46,812	7 9	40 2					
499	45	38,371	5 6	32 9	10 3	37 3	110	81,400	500
749	23	25,341	2 8	21 7					
999	14	17,672	1 7	15 2	1 4	8 7	15	18,904	1,000

Notes For U K all establishments with more than 10 employees included, 9,529 smaller establishments with 21,450 employees (mostly repairers) were excluded, 308 establishments with more than 10 employees (employing altogether 6,167 persons), classified as repairing firms, are also excluded For U S all establishments with less than $5,000 output were excluded.

Source *Census of Production*, 1935, *Census of Manufacturers*, 1939

Table 120 (*c*) *Degree of concentration in biggest business units, U K.* 1935

Employment in the three largest business units=9% of total employment in the industry

Source H Leak and A Maizels 'The Structure of British Industry', *Journal of the Royal Statistical Society*, 1945, p 188

(*d*) *Horse-power per* 100 *operatives**

U K	(1930)	42 h p
U S	(1939)	68 ,,

* For the U K 'power in use' as computed by the U K *Census*, for the U S. 'power installed' as computed by the U S. *Census*.

APPENDIX 21

HOSIERY

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

Comparison between the two countries is influenced by the following factors:

(1) The product structure in the two countries is different, in the U.K. stocking and hose account for about 40% of the value of output, underwear and outerwear for 20% each; in the U.S. in 1939 over 60% of the output by value is accounted for by stockings and hose, 15% by underwear and somewhat less by outerwear. Other products account for the rest in both countries.

(2) The basic raw material is different In the U.K. in 1935 42% of all yarn by quantity was cotton, 41% wool, 15% rayon and 2% silk In the U.S. in 1937 of yarn purchased 59% was cotton, 17% rayon, 9% wool, 8% silk and 7% mixed; this does not take into account the yarn made in the hosiery trade itself.

(3) In the U.S. part of the hosiery trade is integrated in the sense that some plants spin their own yarns from new fibres

(4) Output in the two countries is compared on the basis of re-valuing the quantity of output for the main groups of products at U K. and U.S average prices Owing to substantial variation in the product make-up within the main groups the estimates are necessarily approximate.

II. COMPARATIVE DATA

Table 121. *Output, employment and productivity in the U K and U S hosiery industries*

(a) Output

	Quantity			Value			Average values		
	U K (1935) ('000)	U K (1937) ('000)	U S (1939) ('000)	U K (1935) (£ millions)	U K (1937) (£ millions)	U S (1939) ($ millions)	U K (1935) (£ millions)	U K (1937) (£ millions)	U S (1939) ($ millions)
Stockings and hose (dozen pairs)	31,176	35,981	152,342	16 1	18 4	406 9	0 516	0 511	2 67
Underwear (dozens)	11,627	12,789	34,706	10 7	11 7	101 8	0 920	0 915	2 93
Outerwear (dozens)	5,064	4,901	7,681	9 7	10 0	83 7	1 915	2 040	10 90
Gloves (dozen pairs)	585	607	2,368	0 3	0 3	12 3	0 512	0 572	5 19
Knitted fabric (lb)	25,376	27,098	79,754	5 4	4 7	54 5	0 213	0 172	0 68
Total				£42·2	£45 1	$659 2			
* Weighted output	100		340-342						
		100	311-316						

* Individual groups valued at U K and U S average prices respectively.

Table 121 (*b*) *Employment*

	U K (1935)	U K (1937)	U S (1939)
Number of persons employed	115,273	119,936	250,035
Number of operatives employed	105,622	109,747	236,628
Estimated number of persons producing output	123,200*	122,095*	230,700
Estimated number of operatives producing output	112,800*	111,722*	218,340
Actual hours of work per week	48 1		36 2
Ratio of persons producing output	100	(100)	187 (189)
Ratio of operatives producing output	100	(100)	194 (195)

* Output produced in other industries was greater than 'other products' produced in the hosiery industry

(*c*) *Productivity*

	U K (1935)	U K (1937)	U S (1939)
Output per employee	100	(100)	183 (166)
Output per operative	100	(100)	176 (161)
Output per man-hour (operatives)	100		234
Value of net output per head	£163	£175	$1,509

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 122 *Average size of establishment, concentration of employment and horse-power per operative in the U K and U S hosiery industries*

(*a*) *Average size of establishment*

	No of operatives
U K (1935)	112
U S (1935)	119
(1937)	128
(1939)	113
U S (1939)	
Hosiery fully fashioned	195
Hosiery seamless	143
Knitted cloth	48
Knitted outerwear (regular factories)	39
Knitted outerwear (contract factories)	18
Knitted underwear	194
Gloves	279

Table 122 (*b*) *Concentration of employment*

Size of establishment (number employed)	Number of establishments								
	U K (1935)	U S (1939)							
	All hosiery	All hosiery	Fully fashioned	Seamless	Knitted cloth	Gloves	Outerwear: Contract factories	Outerwear: Regular factories	Underwear
Up to 99 (100)	639	1,500	269	263	195	10	229	437	97
100-999 (101-1,000)	294	565	216	166	34	9	4	39	97
1,000 (1,001) and over	6	24	14	4	—	1	—	—	5
Total	939	2,089	499	433	229	20	233	476	199
Size of establishment (number employed)	**% proportion of employed***								
	%	%	%	%	%	%	%	%	%
Up to 99 (100)	24	18	11	17	33	9	85	56	12
100-999 (101-1,000)	65	65	62	73	67	91†	15	44	68
1,000 (1,001) and over	11	17	27	10	—	—	—	—	20
Total	100	100	100	100	100	100	100	100	100

* For the U K all 'employees', for the U S 'operatives'. U S size groups in brackets
† Including one firm with 1,001 and over employed

Table 122. (*c*) *Horse-power per* 100 *operatives**

U K (1930)	31 h.p.
U S (1939)	
Hosiery fully fashioned	67 „
Hosiery seamless	67 „
Knitted cloth	245 „
Gloves	26 „
Outerwear (regular factories)	75 „
Outerwear (contract factories)	51 „
Underwear	118 „

* For U K 'power in use' as defined by the U K *Census*, for U S 'power installed' as defined by the U S *Census*

APPENDIX 22

BREWING

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

Productivity comparisons are affected by the fact that the British *Census* treats wholesale bottling as a separate industry, while bottling appears to be included in the U S industry In order to put employment data on a comparable basis, it will be necessary to estimate the number employed in the bottling of beer in the U K industry.

Output is measured in bulk barrels That is, no attention is paid to the gravity of the beer.

II. COMPARATIVE DATA

Table 123 *Output and employment in the U K. and U S brewing industries*

	Output ('000 barrels)		No of operatives employed in trade§	Correction factor‖	Estimated number of operatives producing output	Actual hours of work per week
	(*a*) Original data	(*b*) Converted to comparable basis‡				
U K (1935)	21,876*	21,876	Brewing 43,946	0 90	50,541	48 9
			Bottling 10,990	1 00		
U.S (1935)	45,767†	32,815	39,169	0 96	37,600	—
(1937)	55,472†	39,773	47,037	0 97	45,625	38 8
(1939)	52,880†	37,915	36,088	0 97	35,000	39 5

* In bulk barrels, i e barrels of 36 gallons irrespective of gravity

† In barrels of not more than 31 wine gallons

‡ Converted to comparable basis on the assumption that each U S barrel contains 31 gallons, and that the U S gallon corresponds to 0 83 imperial gallon (correction factor 0 717)

§ The U S definition of the trade suggests that bottling is included in the U S industry

‖ The ratio of beer output (by value) to total output (by value) of the trade

Table 124. *Productivity in the U.K and U.S. brewing industries*

	U K	U S		
	1935	1935	1937	1939
Physical output per operative ('000 barrels)	433	872	873	1,083
Index	100	201	202	250*
Physical output per man-hour (operative)	100	—	255	310
Value of net output per head	£927	$7,150	$7,130	$10,060

* The 1939 U S *Census* indicates in addition to manufacturing personnel proper the number of persons employed in distribution, construction and other functions If we compare (*a*) *output per manufacturing employee* (including manufacturing employees and salaried officers of corporations) and (*b*) *output per employee* (including all employees), we get the following indices

U K (1935) =100
U S (1939) (*a*)=275
(*b*)=188

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS*

Table 125. *Average size of establishment, concentration of employment and horse-power per operative in the U K and U S brewing industries*

(*a*) *Size of average establishment*

U K (1935) 94 operatives
U S (1935) 59 „
(1937) 72 „
(1939) 60 „

(*b*) *Concentration of employment*†

Size of establishment (number employed)	No of establishments		% proportion of employment	
	U K. (1935)	U S. (1939)	U K. (1935)	U S (1939)
			%	%
Up to 99 (100)	456	522	31	45
100-999 (101-1,000)	130	82	54	55
1,000 and over (1,001 and over)	6	1	15	—
	592	605	100	100

* For U K brewing only

† For the U K all 'employees', for the U S 'operatives' U S size groups in brackets.

(*c*) *Horse-power per* 100 *operatives*‡

U K. (1930) 182 h p
U S (1939) 976 „

‡ For the U K. 'power in use' as defined by the U K *Census*, for U S 'power installed' as defined by the U S *Census*

APPENDIX 23

TOBACCO

I. SPECIFIC FACTORS AFFECTING PRODUCTIVITY COMPARISONS

When comparing productivity in the U.S. and U K. on the basis of the *Censuses*, allowances have to be made for the fact that the *Census* figures cover only partially the process of stripping of the tobacco leaf (i e. removing the stem or mid-rib). A certain proportion arrives at the manufacturing plants previously stemmed. The man-hours required to manufacture cigarettes and other tobacco products should therefore be increased to account for man-hours involved in green-stemming (i.e stemming before storage for maturing), or in stemming in separate stemmeries not covered by the *Census* reports.

Another factor to be considered is that the U.K. *Census* treats the whole tobacco manufacturing industry as one industry, whereas the U.S. *Census* distinguishes between three sectors: mainly cigarette manufacturers, mainly cigar manufacturers and mainly smoking and chewing tobacco and snuff manufacturers. As the relative importance of each product is very different (and the relative man-hours needed for each of the three products are also different) in the two countries it will be necessary to estimate separately the man-hours used in the U.K for making cigarettes, cigars and tobacco. In reality, of course, these various products are often produced in the same plant.

II. BASIC FACTS AND COMPARISONS

In Table 126 the basic facts as derived from the *Censuses* are set out; in Table 127 productivity comparisons are given. To arrive at these comparisons from the basic facts a great many adjustments and estimates were necessary. These are set out below.

(1) *Adjustment of labour requirements for stripping done outside the "Census" industry*

First of all it is necessary to adjust (increase) labour requirements making the assumption as if in both countries all stripping had been done within the *Census* trade. Adjustment on this account is very important, as stripping requires a great deal of labour. In order to obtain an estimate (*a*) the amount of tobacco stripped outside the *Census* trade, (*b*) the proportion stripped by hand and by machine respectively, and (*c*) the man-hours needed for each process per unit of unstripped tobacco have to be ascertained.

(*a*) *Quantities stripped outside the 'Census' trade*

U.K All tobacco stripping done in the U K. is covered by the *Census*, but a certain proportion of the tobacco used in manufacture is imported in the form of strips and is thus stripped outside the *Census* coverage. The extent of the use of strips can be obtained from the Customs and Excise figures. For

the calendar year 1935, U.K. gross clearances of unmanufactured tobacco were:

(1) Leaf	178,743,000 lb.
(2) Strip	40,990,000 lb
(3) Total	219,733,000 lb
(4) Total unstemmed, equivalent after increasing weight of strip, above	231,633,000 lb.

U.S. The weights of tobacco used in manufacturing cigarettes, cigars and manufactured tobacco are given in the annual report of the Commissioner of Internal Revenue, and for the calendar year 1939 were as follows.

	Cigarettes	Cigars	Tobacco and snuff	Total
		('000 lb)		
(1) Stemmed leaf	291,329	33,254	52,759	377,342
(2) Unstemmed leaf	99,618	53,669	142,369	295,656
(3) Scrap	15,807	20,015	30,578	66,400
(4) Total	406,754	106,938	225,706	739,398
(5) Total unstemmed equivalent (adding one-third to (1) and (3)	509,133	124,694	253,485	887,312

It is well known that a substantial proportion of the tobacco leaf used by the U S. tobacco industry is received by the manufacturers already stripped. It is either stemmed green—i e. in a redrying plant, prior to redrying, or it is stemmed in a separate stemmery, which is not an integral part of a manufacturing plant, immediately prior to manufacture. Neither of these two types of establishment is covered by the *Census*. It appears from the above Internal Revenue figures that almost four-fifths of all leaf (taking unstemmed equivalent) used in making cigarettes is stripped outside the *Census* coverage, and there is evidence that this proportion is probably substantially overstated. The issue is controversial. For purposes of this paper it has been assumed that the Internal Revenue figures reflect the correct position.

(b) Proportion of tobacco hand and machine stripped outside the 'Census' industry

U.S. Taking the ratio of leaf used for making cigarettes which is stripped (outside the *Census* coverage) in non-manufacturing stemmeries to leaf stripped in green stemmeries as 4 to 1, the following two limits appear to be reasonable on the basis of available evidence:

	Minimum allowance	Maximum allowance
Machine stemmed	100%	75%
Hand stemmed	Nil	25%

The same limits are assumed to apply for tobacco stemmed outside the *Census* coverage used in the manufacture of smoking and chewing tobacco In the cigar industry only filler leaf is probably stripped outside the *Census* coverage and it is assumed that this is partly machine stripped and partly hand stripped

U.K. For the U K. a much higher proportion of hand stripping appears to be reasonable.

(*c*) *Man-hours needed for stripping*

U S It is assumed both in respect of stemmed tobacco used for cigarettes and for smoking tobacco that 25 operative man-hours are required per thousand lb. machine stripped, and 100 hours per thousand lb hand stripped. It appears that 100 hours per thousand lb. is a reasonable average to take for stripping cigar fillers

U.K For the U K the estimated stripping operative hours are assumed to be the same for hand stripping and somewhat higher for machine stripping. The latter is explained by differences in machine speeds, attributable *inter alia* to differences in requirements in respect of stem cleanliness.

(ii) *Estimates of labour requirements for the three sectors of the U.K. tobacco industry*

The total man-hours used to produce the U K. output cannot be apportioned between cigarettes, cigars and pipe tobacco without making an estimate as to the relative man-hours needed to produce these three products On the basis of available evidence it has been estimated that the average PMH of cigarettes, cigars (including whiffs) and smoking and chewing tobacco and snuff was in the ratio of 100 : 10 : 40. The PMH of the same product groups in the U S. can be calculated from the 1939 *Census* (after making allowances for stripping outside the *Census* coverage, as shown in Table 126). It has been assumed that the same ratios apply to 1937 and 1935.

(iii) *Other adjustments*

(1) *Conversion factors* used in converting cigarettes from count to manufactured weight (without paper for cigarettes) were:

	lb per thousand	
	U K.	U S
Cigarettes	2 2	2 3
Cigars		18·5

The U K. figures are estimates applicable to 1935, the U.S. figures are based on the reports of the Bureau of Internal Revenue

The U K *Census of Production* includes the weight of cigarette paper in the weight of cigarettes, which has therefore been deducted. Both conversion factors relate to the weight of the finished product.

(2) *Output of bonded factories*

For the U K in 1935 the output of bonded factories (cigarettes and tobacco) is shown in *one* figure (under the heading of 'Cavendish and Negrohead') in the *Census*, it has been included in smoking tobacco.

(3) *Average weekly hours and average hours per annum*

The U S figures for 1939 are based on data derived from the 1939 *Census of Manufactures*.* For 1935 and 1937 the estimates of weekly hours made by Mr. Fabricant were taken,† multiplied by 52 to get annual figures. Aggregate

* *Man-hour Statistics for 171 Selected Industries*, prepared by A F Beal and published jointly by the Department of Commerce and the Department of Labor, Washington, March, 1942

† S Fabricant, *Employment in Manufacturing*, 1899-1939, New York, National Bureau of Economic Research, 1942, p. 237.

weekly working hours for the U S tobacco industry as a whole for 1935 and 1937 were worked out on the assumption that the proportion of wage-earners in the cigarette, cigar and manufactured tobacco sections were the same in these years as in 1939 The U K. figure of actual hours worked relates to the last pay week in October 1935 as ascertained by the Ministry of Labour. Annual figures were obtained by multiplying the weekly figures by 52

(4) *U.S. smoking tobacco output in* 1935

The 1935 U.S *Census of Manufactures* does not give details of the weight of smoking and chewing tobacco and snuff produced. Consequently the figures for total production, taken from Internal Revenue sources, are used instead of the *Census* figures. The differences are negligible.

(5) *By-products in the three sectors of the U.S. tobacco industry*

It is assumed that the average weekly hours calculated by Fabricant (op. cit., p. 237) on the basis of *Census* figures for the different tobacco products applies to the *Census* sections (i e 'mainly cigarette manufacturing, etc ') and also that stripping outside the *Census* coverage applies proportionately to the different *Census* groupings In order to work out the production per man-hour for the three product groups in 1939 three simultaneous equations have to be solved.

III. FACTORS AFFECTING PRODUCTIVITY COMPARISONS

It is necessary to distinguish between purely technical and institutional factors on the one hand and economic factors on the other. Some of these factors are discussed below, but no attempt can be made without further investigations to give a full explanation of the differences.

(1) *Technical and institutional factors*

One of the technical factors affecting productivity comparisons in the U.K. and U.S tobacco industries is the proportion of leaf used which does not require stripping (quite apart from the leaf stripped outside the *Census* coverage) In the U.K probably at least 95 per cent of the leaf is stripped before use, in the U S cigarette industry this proportion is lower. The U.S. industry uses about 10 per cent Oriental leaf and another 5 per cent Maryland leaf, neither of which requires stripping. The proportion of scrap tobacco used in the U S. is also higher than in the U.K.

Differences in excise regulations and the level of duty are another technical factor. In the U.S. duty is imposed on the finished product, while in the U.K. it is imposed on the raw material, and the level of duty—even at the 1935 rates—made it a very much more expensive raw material than its U S counterpart, and one which therefore required much care and additional man-hours in handling In consequence of using an expensive material the U.K industry tends to minimize wastage of leaf The lower proportion of leaf which is machine stripped as against hand stripping and the lower speed of the stripping machines in the U K are not unconnected with this factor.

A number of other U K. regulations (e g. those relating to weights and measures, moisture content, segregation of tobacco types etc.) also entail employment of some extra personnel.

(ii) *Economic factors*

Among the economic factors discussed below the most important ones are: the degree of standardization and the quality of the product, the average size of the producing unit, and size concentration and the degree of mechanization.

There is far greater standardization in the U.S. than in this country Fewer brands are offered to the public, particularly in the smoking tobacco trade. In the U K. competition before the war has to a considerable extent taken the form of attempting to meet individual tastes rather than producing only a very few standardized products This affects man-hour requirements per unit both in the manufacturing and packing as well as in the despatching processes.

Quite apart from standardization, cigarettes in the U.K. are manufactured to technical specifications of perhaps narrower tolerances than in the U S. which affects both machine and handwork speeds.

A comparison of the pipe tobacco sector is materially affected by the higher proportion of snuff in the U.S output, as snuff when manufactured on a large scale requires very much less labour than smoking tobacco In the U S. in 1939 about 12% of all manufactured tobacco (other than cigarettes and cigars) was snuff, while in the U.K 2% of such tobacco was snuff. On the other hand, chewing tobacco, which requires more labour per unit than smoking tobacco, is proportionately more important in the U S. In the U S in 1939 33% of all manufactured tobacco (other than cigarettes and cigars) was chewing tobacco: in the U.K. only a negligible proportion (about 2%) was actually chewed, but the type which was mainly selected for chewing—namely, hard tobaccos and particularly hard-pressed spun tobaccos (roll and twist), and which require a considerable amount of labour per unit—formed about 20% of the U.K. pipe tobacco production in 1935. In the U.S. spun tobacco is of small importance and the main types of smoking tobacco are granulated or are cigarette types of tobacco. For pipe tobacco in the U.S., volumetric machine packing also saves labour, while in the U.K. tobacco is weighed by hand to an exact weight.

As for cigars, in the U.K. a high proportion are whiffs which require more labour per unit.

For reasons mentioned above, of the three main products cigarettes are rather more comparable in the two countries than either pipe tobacco or cigars. In view of the wide range of variation in the man-hours requirements of the different sub-products included in the cigar and pipe tobacco product groups (e.g the range from chewing tobacco labour requirements to those of snuff), it can be argued that these particular product groups are still too wide and that the relevant comparisons should be made between more closely comparable product groups.

Differences in the size of plant and mechanization in the U.K. and the U S. are shown in Tables 128 and 129.

It can be seen that the cigar industry in the U.S. consists of many small establishments, smaller than the average U.K. establishment. It uses far less horse-power per worker than the cigarette or the tobacco manufacturing establishment in the U S., even less than the average U.K. establishment.

The average U.S. establishment in the manufactured tobacco section is also relatively small, but appears to be more mechanized than the average U.K. establishment. In the cigarette section the average establishment in the U.S. is both larger and more mechanized than the average U K. establishment appears to be (even allowing for the increase in mechanization since 1930 in the U.K.).

In the U.S. conveyors are used to a larger extent and have had the effect of almost completely eliminating floor labour and trolley pushing. These conveyors are not used to the same extent in the U K. neither could they be used perhaps to the same extent for technical reasons. The U.S. may also have some superiority in lay-out

Lastly it should be noted that the proportion of female workers is somewhat higher in the U.K. (72·5% in 1935) than in the U S. (66·9% in 1939).

Table 126 *Output, employment and man-hours worked in the U K and U.S tobacco industries*

Production	U K	U S					
	1935	1935	1937	1939			
		All tobacco manufacturers	All tobacco manufacturers	All tobacco manufacturers	Mainly cigarette manufacturers	Mainly cigar manufacturers	Mainly smoking and chewing tobacco and snuff manufacturers
Manufactured out of bond							
Cigarettes count (mn)	66,950	139,969	169,946	180,616	180,575	—	41
wt incl cigarette paper ('000 lb)	153,187	—	—	—	—	—	—
,, excl ,, ,, ,, ,,	147,825	321,929	390,877	415,417	415,323	—	94
Cigars and whiffs count (mn)	158	4,863	5,345	5,223	49	5,166	8
weight ('000 lb)	1,071	89,969	98,881	96,632	906	95,579	147
Chewing and smoking tobacco ('000 lb)	50,327	306,633	303,022	306,008	148,452	1,053	156,503
Snuff ('000 lb)	921	36,095	37,141	37,947	—	—	37,947
Manufactured in bond	1,094	—	—	—	—	—	—
Total manufactured weight ('000 lb)	201,238	754,626	829,921	856,004	564,681	96,632	194,691
Covered by *Census*							
Number of operatives	35,695	90,543	92,158	87,525	27,426	50,897	9,202
Production per operative per year (lb)	5,638	8,334	9,005	9,780	20,589	18,986	21,157
Average weekly hours	45·8	33·5	35·2	—	34·5	33·3	34·3
Average annual hours	2,382	1,742	1,830	—	1,793	1,734	1,784
Total operative man-hours ('000's)	85,025	157,726	168,649	153,846	49,175	88,255	16,416
Production per man-hour (lb)	2·37	—	—	—	—	—	—
Not covered by *Census*							
Operative hrs for stripping ('000 hrs)							
Minimum allowance	4,125	17,698	20,017	20,119	11,651	7,036	1,432
Maximum allowance	4,707	26,220	29,531	30,011	20,455	7,043	2,513
Average	4,416	—	—	—	—	—	—
Total operative hours ('000's)							
Minimum allowance	89,150	175,424	188,666	173,965	60,826	95,291	17,848
Maximum allowance	89,732	183,946	198,180	183,857	69,630	95,298	18,929
Average	89,441	—	—	—	—	—	—
Production per man-hour (lb /hr)					Cigarettes	Cigars	Tobacco & snuff
Upper limit	2·26	4·30	4·40	4·92	8·95	1·00	10·99
Lower limit	2·24	4·10	4·19	4·66	7·63	1·00	10·36
Average	2·25	—	—	—	—	—	—

Table 127. *Comparison of productivity in the U K. and U S tobacco industries*

Production per man-hour (lb /hr)

Product group	U K 1935			U S 1939		U S 1935		U S 1937		U S 1935 as % of U K. 1935	
	Lower limit	Upper limit	Average	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Minimum	Maximum
Cigarettes	3 23	3 25	3 24	7 63	8 95	6 85	8 00	6 99	8 20	212	246
Cigars	0 31	0 32	0 32	1 00	1 00	0 89	0 89	0 92	0 92	287	278
Tobacco and snuff	1 29	1 30	1 30	10 36	10 99	9 31	9 83	9 50	10 07	722	756

Table 128 *Concentration of production in the U K and U S tobacco manufacturing industries*

Size of establishment No of employees (U K)	No of establishments					Proportion of employment					Size of establishment No of operatives (U S)
	U K., 1935	U S , 1939				U K , 1935	U S , 1939				
		Cigars	Cigar-ettes	Tobacco and snuff	All		Cigars	Cigar-ettes	Tobacco and snuff	All	
Up to 99	67	501	14	109	624	6 2	14 5	0 8	14 5	10 1	Up to 100
100–999	42	88	7	21	116	34 5	55 5	2 6	45 3	37 9	101–1,000
1,000 and over	9	9	14	2	25	59 3	30 0	96 6	40 2	52 0	1,001 and over
Total	118	598	135	132	765	100 0	100 0	100 0	100 0	100·0	

Table 129. *Size of average establishment in the U.K. and U S. tobacco manufacturing industries*

	No of establishments	Employment (operatives)	Average no of operatives per establishment	Horse-power per 100 operatives*
U K, 1935	118	35,695	303	44 (1930)
U S, 1939				
Cigars	598	50,897	85	38
Cigarettes	35	27,426	784	217
Tobacco manuf	132	9,202	70	234
All tobacco	765	87,525	114	—

* For U K, 'power in use' as computed by the U K *Census*, for U S, 'power installed' as computed by the U S *Census*

IV. COMPARISON OF BRITISH AND SWEDISH TOBACCO INDUSTRIES

Basic data for Sweden were derived from the annual report for 1935 of the Swedish Tobacco Monopoly which gives the following picture·

Table 130 *Output, employment and productivity in the Swedish tobacco industry in 1935**

	Output ('000 lb) U K.	Output ('000 lb) Sweden	Employment including miscel employees Sweden	Total annual hours worked ('000) Sweden	Production per man-hour Sweden	Production per man-hour U K.
	1†	2	3	4	5	6†
Cigarettes	147,825	4,148	630	1,305	3 18	3·24
Cigars }	1,071	377	1,270	2,650	55	32
Whiffs }		1,093				
Pipe tobacco }	51,421	2,195	113	249	8 80	1 30
Chewing tobacco‡ }		228	127	279	0 82	
Snuff	921	9,853	151	325	30 33	
Total	201,238	17,894	2,291	—	—	

* Based on ascertained annual actual hours worked
† Columns (1) and (6) are based on Table 126.
‡ See reference to chewing tobacco on p 204

The U.K. figures are based on 100% leaf using, i.e allowance is made for the labour that would have been required to strip such leaf as is imported in strip. No such allowance is made for Sweden, as it is reasonable to assume that all non-manufactured tobacco is imported in leaf form. It should be noted however that approximately one-third of the leaf (other than cigar type) used in Sweden is of the Oriental type not requiring stripping. Offsetting the foregoing advantage of Sweden to a certain extent is the fact that a larger proportion of cigarettes are tipped in Sweden than in the U.K.

APPENDIX 24

SOAP

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

Comparison of the soap industries in the two countries is made difficult by the fact that in the U K. the soap industry is treated as a sub-group of the soap, candle and perfumery trade In the U S on the other hand, the soap and glycerine industry is treated as a separate trade, but the complication arises from the fact that some (though not a large) proportion of the soap output is made in other trades, while the soap industry itself produces a number of other products

The procedure followed was to treat soap (as measured by weight) as a homogeneous commodity, irrespective of the form in which it is produced, or the use made of it, further, to take the total soap production in the two countries (whether produced in the trade or in other trades) and to estimate the corresponding number of operatives. These latter data were extracted by adjusting the employment data for the soap trade by the ratio of the value of soap output to the total value of the output of the trade. Employment figures are, therefore, somewhat arbitrary

II. COMPARATIVE DATA

Table 131 *Output, employment and productivity in the U K. and U S. soap industries*

(*a*)

	Output ('000 cwt)	Estimated no of employees	Estimated no of operatives	Actual hours of work per week
U K, 1935	9,973	17,826	12,513	47 7*
U.S, 1935	27,280	15,774	12,868	38 0
1937	28,430	15,722	12,493	39 8
1939	31,830	15,425	12,180	39 8

* Soap, candles and glycerine

(*b*)

	Output per employee	Output per operative		Output per man-hour (operative)
	cwt.	cwt	Index	
U K, 1935	559	797	100	100
U.S, 1935	1,730	2,120	266	334
1937	1,808	2,275	286	343
1939	2,063*	2,613	328	393

* Taking into account distribution, construction, etc personnel, this figure would be 1,76c

CP

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Product structure

In the U K. in 1935, nine-tenths of the soap produced was for household and domestic purposes and one-tenth was for industrial purposes (mainly the textile industry) and laundries. In the U S. a larger proportion of toilet soap with a high labour content was produced. To this extent the U S productivity advantage has been underestimated.

Table 132 *Product structure of the U K and U.S. soap industries*

Type of product	U K (1935)	U S (1939)
	%	%
Toilet soap	6 6	11 5
Shaving soap	0 3	0 4
Hard soap (laundry soap U S)	54 0	34 8
Powder and flakes	30 0	43 6
Polishers and scourers	4 6	5 2
Others	4 5	4 5
Total	100 0	100 0

Table 133 *Average size of establishment, concentration of employment and horsepower per operative in the U K and U S soap industries*

(*a*) *Average size of establishment*

	No of establishments	Average number of employees
U K, 1935	65	274
U S, 1935	238	72*
1937	232	76*
1939	264	65*

* (This is misleading unless taken in conjunction with the concentration data in (*b*) below.)

(*b*) *Concentration of employment in the U S*

Size of establishment (No of operatives)	U S (1939) No of establishments	U S (1939) No of operatives	U S (1939) % of operatives
Up to 100	231	1,750	12 8
101-1,000	30	7,894	57 9
1,001 and over	3	3,980	29 3
	264	13,624	100 0

Notes In the U S. 13 establishments, of 251 operatives and over, employed 62% of all operatives

In the U K out of the 65 establishments, 10 that were owned by one business unit produced about 55% of total output.

(*c*) *Horsepower per* 100 *operatives**

U S, 1939	696 h p
U K, 1930†	200 ,,

* For the U K 'power in use' as computed by the U K *Census*, for the U S 'power installed' as computed by the U S *Census*

† Soap, candle and perfumery trade

APPENDIX 25

MARGARINE

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPAPISONS

Comparison of margarine industries in the two countries is made precarious by the fact that in the U S less than two-thirds of all 'margarine' produced is made by the oleo-margarine industry, the rest is made as a secondary product in the meat-packing industry, or in other industries. Furthermore, less than two-thirds of the value of the output of the oleo-margarine industry is accounted for by the main product, and the rest is accounted for by other products, such as salad dressings, salad and cooking oils, etc. An approximate estimate for the U S can be arrived at, therefore, either by taking the margarine output of the oleo-margarine industry and estimating the operatives concerned (in the ratio of its value to the total value of gross output of the trade), or alternatively, by taking the total margarine output in all industries and estimating (in the ratio of its value to the total value of gross output of the oleo-margarine trade) the operatives involved. There is a substantial margin of error involved in both cases It should also be noted that the margarine produced in the U S. is known to be a product of lower quality than margarine produced in the U.K and is used mainly for cooking purposes.

II. COMPARATIVE DATA

Table 134 *Output, employment and productivity in the U K and U S margarine industries*

(*a*)

	Output (million lb)		Estimated number of operatives	
U K , 1935	395 2		2,140	
	Total output	Output of the oleo-margarine industry	Producing total output of margarine	Producing in oleo-margarine industry
	(*a*)	(*b*)	(*a*)	(*b*)
U S , 1935	388 9	197 9	1,717	911
1937	397 4	237 4	1,388	846
1939	307 4	181 3	929	592

(*b*)

	Physical output per operative				Index	
	'000 lb		cwt			
U K , 1935	184 6		1,650		100	
	(*a*)	(*b*)	(*a*)	(*b*)	(*a*)	(*b*)
U S , 1935	226 5	217 2	2,022	1,939	123	118
1937	286 3	280 6	2,556	2,505	155	152
1939	330 9	306 2	2,954	2,734	179	166

Note Column (*a*) total margarine made, column (*b*) made in the oleo-margarine industry

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 135 *Average size of establishment in the U.K. and U.S. margarine industries and horsepower per operative in the U.S. margarine industry*

(*a*) *Average size of establishments*

U.K., 1935	178 operatives
U.S., 1939	55 ,,

(*b*) *Horsepower per* 100 *operatives*

U.S., 1939	1,057 h.p.

Note No U.S. establishment employs more than 250 operatives, on the other hand in the meat-packing trade the size of establishments is larger

APPENDIX 26

MATCHES

I. COMPARATIVE DATA

Table 136. *Output, employment and productivity in the U K and U S match industries*

(a) Output and employment

	Output (millions of matches)	Employment		Actual hours of work per week
		Operatives	Employers	
U K, 1935	78,833	3,384	3,767	41 9
U S, 1935	368,562	5,075	5,495	
1937	411,150	5,261	5,693	
1939	418,665	5,426	5,844	

(b) Productivity

	Output per employee (millions of matches)	Output per operative		Value of net output per operative
		Millions of matches	Index	
U K, 1935	20 9	23 3	100	£448
U S, 1935	67 1	72 6	312	$2,246
1937	72 2	78 2	336	$2,031
1939	71 6	77 2	331	$2,115

II. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 137 *Average size of establishment, concentration of employment and horsepower per operative in the U K and U S match industries*

(a) Average size of establishment

U K, 1935	113 operatives
U S, 1935	211 „
1937	210 „
1939	194 „

*(b) Concentration of employment**

Size of establishment (number employed)	No of establishments		% proportion of employment	
	U K (1935)	U S (1939)	U K (1935)	U S (1939)
Up to 99 (100)	22	13	15 4	11 6
100 (101) and over	8	15	84 6	88 4
Total	30	28	100	100

* For the U K all 'employees', for the U S 'operatives' U S size groups in brackets

*(c) Horsepower per 100 operatives**

U K, 1930	120 h p
U S, 1939	454 „

* For U K 'power in use' as computed by the U.K *Census*, for U S 'power installed' as computed by the U S *Census*

APPENDIX 27

BISCUITS

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The comparison is made between the 'biscuit trade' as defined by the United Kingdom *Census of Production* and the 'biscuits, crackers and pretzels trade' of the United States *Census.*

Output is measured by weight, and no allowance was possible for quality differences

II. COMPARATIVE DATA

Table 138. *Output, employment and productivity in the U K and U S. biscuit industries*

	U K (1935)	U S (1939)
Output ('000 cwt)	4,813	13,729
All employees	44,001	31,561
Operatives	36,495	29,173
Estimated number of employees producing output	43,400	30,500
Estimated number of operatives producing output	36,020	28,200
Actual hours worked per week	48 7	41 7*
Output per employee (cwt)	111	450
,, ,, operative ,,	134	487
,, ,, ,, (index)	100	363
,, ,, man-hour	100	424
Value of net output per operative	£252	$4,070

* Baking

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 139 *Average size of establishment, concentration of employment and horsepower per operative in the U.K and U.S. biscuit industries*

(a) *Average size of establishment*

U K, 1935 372 operatives
U S, 1939 82 ,,

(b) *Concentration of employment**

Size of establishment (number employed)	No of establishments		% proportion of employment	
	U K	U S	U K	U S
Up to 99 (100)	39	271	4	21
100-999 (101-1,000)	45	83	30	60
1,001 (1,000) and over	14	2	66	19†
Total	98	356	100	100

* For the U K all 'employees', for the U S 'operatives' U S size groups in brackets
† 501 and over

(c) *Horsepower per* 100 *operatives**

U K (1930)	Bread and biscuits	78 ,,
U S (1939)	Biscuits	257 h p
	Bread	177 ,,

* For the U K 'power in use' as computed by the U K *Census*, for the U S 'power installed' as computed by the U S *Census*

APPENDIX 28

BEET SUGAR

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

Comparison is difficult owing to potential differences in the activities of the two industries as well as because the industries are seasonal in their operations

The British industry is concerned with producing raw sugar out of sugar beet as well as refining it. Some firms, however, produce raw sugar only, and allow the refining to be done by the refineries. At the same time, some beet sugar factories do refine imported sugar in their off season to spread their overhead costs.

In the U S. practically the total amount of sugar produced by the beet sugar factories is refined sugar.

II. COMPARATIVE DATA

Table 140 *Output, employment and productivity in the U K and U S. beet sugar industries*

	U K (1935)	U S (1939)	Ratio U K = 100
Beet sugar (refined '000 cwt)	7,753		
Beet sugar (unrefined '000 cwt)	5,376		
Total in refined equivalent	10,979*	29,186	266
Molasses ('000 cwt)	1,027	4,448	433
Beet pulp ('000 cwt)	7,584	33,916	447
Estimated number of operatives †	4,476	10,410	233
Output	100	273-287‡	
Output per operative	100	117-123	
Output per operative (in '000 cwt of refined sugar)§	2 45	2 80	
Value of net output per operative	£289‖	$4,749	

* Unrefined converted into refined sugar on the basis of relative prices

† Average for the year Employment in the beet sugar season is appreciably higher· 9,500 in Britain and 27,500 (on 14 October 1939) in the U S

‡ Weighted average, allowing for molasses and beet pulp

§ Not allowing for molasses and beet pulp

‖ Includes subsidies

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 141. *Average size of establishment, concentration of employment and horsepower per operative in the U K and U S beet sugar industries*

(*a*) *Average size of establishment*

U K, 1935	249 operatives
U S, 1939	122 "

Table 141 (*b*) *Concentration of employment**

Size of establishment (number employed)	No of establishments		% proportion of employment*	
	U K.†	U S	U K	U S
			%	%
Up to 99 (up to 100)	11	30	3	23
100 and over (101 and over)	32	55	97	77
Total	43	85	100	100

* For the U K all 'employees', for the U S 'operatives', U S size groups in brackets
† Sugar and glucose

(*c*) *Horsepower per* 100 *operatives**

U K, 1930†	540 h.p
U S, 1939	2,104 ,,

* For U.K. 'power in use' as computed by the U K. *Census*, for U S 'power installed' as computed by the U S *Census*
† Sugar and glucose

APPENDIX 29

GRAIN MILLING

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

The 'grain milling trade', as defined for purposes of the British *Census*, comprises firms engaged in the manufacture of flour and meal, including some breakfast cereals, and in the preparation of animal and poultry feeding stuffs, of which grain was the principal ingredient.

The U S *Census* treats 'flour and other grain-mill products' as one industry and treats cereal preparations and prepared feeds for animals as separate industries Some part of both cereals and prepared feed is produced, however, by firms in the flour and other grain mill products trade, so that its product structure is in fact very similar to that of the British grain milling trade *

The grain milling trade in the U K. is therefore compared with the flour and other grain mill products trade in the U S , and that part of the cereals and animal feed output produced outside the latter industry is disregarded †
The U.S. industry covers merchant mills only As the comparison is based on physical weight only it is approximate.

II. COMPARATIVE DATA

Table 142 *Output, employment and productivity in the U K and U.S. grain milling industries*

	U K (1935)	U S (1937)
Physical output ('000 tons)	8,478	16,200
Average number of persons employed	29,679*	30,319
Number of operatives employed	22,500*	24,771
Actual hours worked per week	47 8	42 3
Output (index)	100	191
Average number of persons employed (index)	100	102
Operatives ,,	100	110
Output per operative ,,	100	174
Output per man-hour (operative) (index)	100	197
Output per employee (tons)	286	534
Output per operative ,,	377	653
Value of net output per operative	£522	$5,809

* Excluding rice and rice products

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 143 *Average size of establishment, concentration of employment and horsepower per operative in the U K. and U.S grain milling industries*

(a) *Average size of establishment*

U K , 1935	46 operatives
U S , 1939	12 ,,

* In the U K about o 6% of the volume was cereals, 9% feedingstuff, and 19% bran and middlings In the U S about o 5% of the volume was cereals, 6% feedingstuff, and 30% bran and middlings

† In the U S of 6 4 million tons (2,000 lb) of prepared animal feed, made chiefly from milled grain, 1 million tons were produced in the grain milling industry, of 647,000 tons of cereals, 81,000 tons were produced in the grain milling industry

Table 143 (*b*) *Concentration of employment*

Size of establishment (number employed)	No of establishments		% proportion of employment*	
	U K †	U S	U K † %	U S %
Up to 99 (100)	431	2,101	46	72
100-499 (101-500)	68	42	47	28
500 and over (501 and over)	3	—	7	—
Total	502	2,143	100	100

* For the U K all 'employees', for the U S 'operatives' U S size groups in brackets
† Including rice.

(*c*) *Horsepower per* 100 *operatives**

U K, 1930	683 h p
U S, 1939	2,259 „

* For U.K 'power in use' as computed by the U K *Census*, for U S. 'power installed' as computed by the U S *Census*

FISH CURING

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

This comparison is of doubtful value owing to the great difference in the products of the two countries The discrepancy between estimates based on value comparisons and those based on comparison of volume suggests that the U S product is of a higher quality and has a higher labour content. This is also confirmed by a comparison of the product structure and average unit values of the output

The comparison is made in Section II between quantities without allowing for quality In Section III data are given on some factors bearing on these productivity comparisons.

II. COMPARATIVE DATA

Table 144 *Output, employment and productivity in the U K and U S. fish curing industries*

	U K (1935)	U S (1939)
Output ('000 cwt)	3,850	650
Estimated number of employees	5,270	1,680
Estimated number of operatives	4,730	1,480
Output per employee (cwt)	731	387
Output per operative (cwt)	814	439
Index	100	54
Value of net output per operative	£203	$2,453

III. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 145 *Average size of establishment, concentration of employment and horsepower per operative in the U K and U S. fish curing industries*

(*a*) *Average size of establishment*

U K, 1935 21 operatives
U S, 1939 17 „

(*b*) *Concentration of employment**

Size of establishment (no of employees)	No of firms		% proportion of employment*	
	U K	U S	U K	U S
			%	%
Up to 99 (100)	234	110	94	52
100 (101) and over	3	4	6	48
Total	237	114	100	100

* For the U K all 'employees', for the U S 'operatives': U S size groups in brackets

Table 145 (*c*) *Horsepower per* 100 *operatives**

U K, 1930	21 h p
U S, 1939	269 „

* For U K 'power in use' as computed by the U K *Census*, for the U S 'power installed' as computed by the U S *Census*

Table 146 *Average values and product structure of the U K and U S fish curing industries*

(*a*) *Average values ex factory*

	U K	U S
All fish cured, per cwt	£1 06	$18 82

(*b*) *Product structure*

Type of product	U K (1935)	U S (1939)
	%	%
Herring	72 6	29 6
Cod	13 6	15 3
Haddock	8 1	5 0
Salmon	0 2	15 2
Other fish	5 5	34 9
	100 0	100 0

APPENDIX 31

MANUFACTURED ICE

I. COMPARATIVE DATA

Table 147 *Output, employment and productivity in the U K. and U S. manufactured ice industries*

	U K 1935	U S 1935	U S 1937	U S 1939
Output ('000 tons)	1,173	29,160	30,420	28,856
Number of persons employed	1,845			19,825
Number of operatives employed	1,564	18,763	18,500	14,990
Output per employee (tons)	636			1,454
Output per operative (tons)	750	1,554	1,644	1,925
Output per operative (index)	100	207	219	256
Value of net output per operative	£493	$5,270	$5,827	$6,549

II. DATA RELATING TO FACTORS AFFECTING PRODUCTIVITY COMPARISONS

Table 148 *Average size of establishment, concentration of employment and horsepower per operative in the U K and U S manufactured ice industries*

(*a*) *Average size of establishment*

U K, 1935	21 operatives
U S, 1935	5 „
U S, 1937	5 „
U S, 1939	4 „

(*b*) *Concentration of employment**

Size of establishment (no employed)*	No of establishments U K (1935)	No of establishments U S (1939)	% proportion of employment* U K (1935)	% proportion of employment* U S (1939)
			%	
Up to 49 (50)	69	3,972	71	n a
50 (51) and over	6	3	29	n a
Total	75	3,975	100	

n a =not available

* For the U K all 'employees', for the U S 'operatives' U S size groups in brackets

(*c*) *Horsepower per* 100 *operatives**

U K, 1930	1,757 h p
U S, 1939	6,493 „

* For the U K 'power in use' as computed by the U K *Census*, for U S 'power installed' as computed by the U S *Census*

PART II

APPENDICES

SECTION II

International Productivity Comparisons in Individual Non-Manufacturing Industries

SECTION II

APPENDIX 32

AGRICULTURE

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

It was explained in Chapter VI that two alternative estimates of productivity can be made One method compares the value of net output per person employed in agriculture, converted into £'s by a purchasing parity rate in terms of prices of agricultural products.

The second method is based on physical output, as far as it is comparable, and involves conjecture as to the number of persons engaged in producing this output.

Tables 149-154 below contain the basic data for making a comparison by the first method. These are followed by a description of the second method. The results of making the comparisons by the two methods are given in Table 21, Chapter VI, p. 78 Table 155 indicates long-term changes in productivity in agriculture in the U K., U.S., and Germany.

II. COMPARATIVE DATA

(1) Data on which a comparison by the net output method was based

Table 149. *The value of gross and of net output of British agriculture*, 1937-1938/9

	(1) 1937-8 (June to May) £ millions	(2) 1938-9 (June to May) £ millions	(3) 1937† £ millions	(4) 1938† £ millions
(1) Value of sales (provisional)	290 0	292 5		
(2) Sundry output	2 5	2 5		
(3) Stock change, growing crops and cults	1 5	—1 5		
(4) Stock change, livestock	6 0	3 5		
(5) ,, ,, other	1 0	—2 5		
(6) Value of gross output	301 0	294 5	280 0	285·0
(7) Less feedingstuffs	76 0	70 0	63·1	59 3
(8) ,, livestock	14 5	15 5		
(9) ,, seeds	4 0	4 5	3 2	3 8
(10) ,, fertilizers	9 5	10 0	8·9	8 9
(11) ,, machinery repair	5 0	5 5		
(12) ,, ,, fuel	3 0	3 5		
(13) ,, contract services	3 0	3 0		
(14) ,, maintenance charges	1 5	1 5		
(15) ,, miscellaneous ,,	9 5	10 0	10 0*	9 5*
(16) Value of net output	175 0	171 0	195 0	203 0

* 15% is allowed for transport, etc , costs in Professor Bowley's calculation

† The output of small holdings (of less than one acre) is not included in the above figures According to Professor Bowley, the gross output of small holdings (including allotments and gardens) amounted to about £15 5 millions in 1930 (Op cit below, p 127) A net output figure of, say, £12 millions for 1938 might be a rough estimate, taking into account the increase in gross output of agriculture as from 1930 to 1938, but excluding the output of allotments and deducting the costs of feedingstuff, fertilizers, etc

Sources Columns (1)-(2), J H Kirk 'The Output of British Agriculture during the War', *Journal of the Proceedings of the Agricultural Economic Society*, June 1946, (3)-(4), A L. Bowley (ed) *Studies in National Income*, N I E S R , Study I, Cambridge University Press, 1942, p 100

Table 150 *The value of gross and of net output in German agriculture*, 1935-6 *and* 1937-8

	1935-6 Rm million		1937-8 Rm million	
(1) Estimated gross cash income from agricultural production without duplication		8,698		9,484
(2) Farm value of products consumed by agriculture		2,900		3,100
(3) Total gross income		11,598		12,584
(*a*) Feedingstuffs	594		842	
(*b*) Livestock (foreign)	24		30	
(*c*) Seeds ,,	52		55	
(*d*) Fertilizers	740		739	
(*e*) Plant fertilizers	20		21	
(*f*) Heating, fuel, etc	268		313	
(*g*) Upkeep of buildings	222		255	
(*h*) Upkeep of inventories	723		848	
(4) Less current costs (*a*)-(*f*)		1,698		2,000
(5) Total net income (3) less (4)		9,900		10,584

Note Rows (*g*) and (*h*) appear mostly to cover depreciation and not only repairs and maintenance

Sources Column (1) *Weekly Report* of the German Institute for Business Research, No 33/34, 1938, column (2) op cit, No 41/42, 1938, rows (*a*)-(*h*) *Wirtschaft und Statistik* (Statistisches Reichsamt), No 21, 1938, pp 850-1.

Table 151. *The value of gross and of net output in U S. agriculture*

($ millions)

	1935	1937	1938	1939	1943
(1) Gross farm income (cash receipts, Government payments, and value of products consumed on farms where produced)	8,979	10,627	9,451	9,928	21,952
(2) Rental value of farmhouses	616	638	620	619	787
(3) Gross farm income, including (2)	9,595	11,265	10,071	10,547	22,738
(4) Less current operating expenditure, viz	2,183	2,749	2,474	2,759	5,346
(i) Feed bought	528	805	557	732	2,262
(ii) Livestock bought, excluding work stock	269	282	310	404	732
(iii) Fertilizer and lime	177	248	226	240	425
(iv) Operation of motor vehicles	435	512	520	545	724
(v) Other cash expenditure	774	902	861	838	1,203
(5) (Maintenance of buildings, machinery and equipment)	870	1,039	1,048	1,088	1,442
(6) Net output					
(i) (1) less (4)	6,796	7,878	6,977	7,169	16,606
(ii) (1) less (4)+(5)	5,926	6,839	5,929	86,081	15,164

Note. There may be some duplication in the gross farm income data, Row 1 H Barger and H H Landsberg put the value of gross output without duplication at $9,110 millions for 1937 (*American Agriculture*, 1899-1939, National Bureau of Economic Research, New York, 1942, pp 372-3) The corresponding value of net output for this year would be $6,361 millions.

Source. U S. Department of Agriculture, *Agricultural Statistics*, 1944, pp. 424-5.

Table 152. *Employment in U K agriculture*

	1937-38 (000's)
Estimated employment in U K. agriculture	1,050-1,150

Note The estimated employment refers to those producing the output as shown in Table 149 It includes workers employed in agricultural holdings, owners of farms who are working, occupiers' families working on the farms, it excludes occupiers' wives and domestic servants

The *Census of Population* shows a higher number of persons 'enumerated' in agricultural occupations, but presumably includes a number of persons for whom agriculture was not their main occupation

Table 153 *Employment in U S. agriculture*

	No of persons employed ('000)				
	1935	1937	1938	1939	1943
Total employment	11,131	10,892	10,789	10,740	10,263
divided into					
Family workers*	8,702	8,261	8,169	8,145	7,857
Hired workers	2,429	2,631	2,620	2,595	2,406

* Includes farm operators and members of their families doing farm work without wages

Note There are two further estimates relating to the number of persons employed in agriculture the 1930 and 1940 *Census of Population* data, and the 1935 *Census of Agriculture* data Differences between the three Censuses are analysed by H Barger and H H. Landsberg *American Agriculture*, 1899-1939, op cit Chapter VI

Source. Bureau of Agricultural Economics Quoted from *Agricultural Statistics*, 1944, page 406

Table 154 *Employment in German agriculture*

	No of people employed ('000)		
	1925	1933	1939
Independent farmers		2,123	
Family helpers		4,476	
Salaried workers		79	
Agricultural workers		2,257	
Total agriculture		8,935	
Add gardening		240	
,, forestry		138	
,, fisheries		30	
Total	9,763	9,343	8,934
Unemployed (incl in total)	23	309	

Notes (1) Wives of farmers are in most (though not in all) cases classified as family helpers Of the 4 5 million persons, about 3 5 millions were women

(2) Seasonal workers (many of them foreign workers) are not included

Sources. For 1925, 1933 *Statistisches Jahrbuch für das Deutsche Reich*, 1936, pp 19-20, for 1939 U S Strategic Bombing Survey, *The Effects of Strategic Bombing on the German War Economy*, Overall Economic Effects Division, 1945, pp 202-3.

(ii) *Data on which a comparison by the physical output method was based*

Physical output, without duplication for inter-farm traffic but including farm consumption, has been estimated for England and Wales on the one hand, and for the U S on the other in the following way.

The following main farm products have been taken into consideration: wheat, barley, corn, oats, rye, beans, sugar beet, potatoes, hops; beef, veal, mutton, pork, poultry, eggs, milk, and wool These products account for approximately 80% of the value of gross output in England and Wales, and for about 75% of the value of gross output in the U.S

The following were excluded fruit, vegetables, glasshouse products, hay, straw and mustard seed, so also were cotton, cotton seed, tobacco and miscellaneous products such as peanuts.

In using this method the main steps involved are

(a) the estimation of the physical gross output, without duplication, for England and Wales,

(b) the estimation of the labour force engaged in producing the above products.

For England and Wales the same ratio was taken as was accounted for by the value of gross output i.e 80% of all persons employed in agriculture. For the U S employment data are available for each producing region; these data are published by the Bureau of Agricultural Economics, and furthermore the relative importance (weight) of the output of single products is also given Thus an approximate estimate can be made of the numbers engaged in producing the farm products listed above

(c) the choice of weights for the output ratios derived from the estimates under (a) and (b)

This can be done according to their relative importance in the value of gross output either of England and Wales, or in that of the United States

The results of the comparisons indicate that in the U.S approximately 10 times as many persons as in England and Wales produce 9-10 5 times the physical output.

(iii) *Long-term changes in agricultural productivity are shown in the following table*

Table 155 *Long-term changes in agricultural productivity in index numbers*

(a) U K.

	(1) Output		(2) Employment	(3) Output per head
	(a)	(b)	(b)	(b)
1900-02		100	100	100
1908	100	—	—	
1910-12		105	107	98
1925	100			
1930-31	104	97	94	104
1934-35	123	115	91	126
1935-36	117	109	89	122
1936-37	122	114	88	130

Source Column (a) *British Agriculture*, A Report of an Enquiry organized by Viscount Astor and B Seebohm Rowntree, London, 1938, p 53, column (b) Colin Clark *Conditions of Economic Progress*, 1940, p 255 Output series are based on Dr Drescher's index (Weltwirtschaftliches Archiv, March 1935) and from 1930-31 onwards on Ministry of Agriculture data, employment data are based on *Censuses of Population* and from 1931 on the *Agricultural Statistics* of the Ministry of Agriculture

Table 155 (*b*) *U S.*

1939=100

	Production	Employment	Output per worker
1909	75 4	113 7	66 3
1910	79 2	113 1	70 0
1920	91 4	105 8	86 4
1930	93 3	104 0	89 7
1937	106 6	101 4	105 1
1938	98 2	100 5	97 7
1939	100 0	100 0	100 0
1940	101 8	98 6	103 2
1941	103 6	96 5	107 4
1942	115 1	96 8	118 9
1943	111 7	95 6	116 8
1944	116 4	93 5	124 5

Source U S Department of Labor, Bureau of Labor Statistics *Productivity in Agriculture,* 1909-42, November 1943, extended, for the period 1942-45, in June 1946 (mimeographed document)

(*c*) *Germany*

	Output	Employment	Output per worker
1880	100	—	
1882		100	100
1890	118	—	
1895	—	101	
1900	144	—	(131)*
1907	—	120	
1913	182	—	
1924	140	—	
1925	—	137	
1930	168		
1933	175	131	133
1937	187	—	
1939	190	125	152

* Employment interpolated

Note Changes in the volume of German agricultural output are given in the Weekly Report of the German Institute of Business Research, 1938, No 43/44 The same source appears to suggest a higher increase in productivity of labour than the table above (which relates the *Census of Population* employment figures to the output indices) This is arrived at, however, by incorrectly relating to output the number of people enumerated in agriculture (Berufszugehorige), which was decreasing in the period, instead of the number of people working in agriculture (Berufstatige) which was increasing in the period The error can be detected by comparing the German and the English versions of the Weekly Reports

For employment data see *Statistisches Jahrbuch fur das Deutsche Reich,* 1938, and *Wirtschaft und Statistik,* 1941

APPENDIX 33

FISHERIES

COMPARATIVE DATA

Table 156. *Output, employment and productivity in U.K. and U.S. fisheries*

(*a*) *U K* 1937

Total output of wet fish (excluding salmon)	21 8 million cwt
Value of total output of wet fish (excluding salmon)	£15 3 millions
Output of shell fish	—
Value of shell fish	£0 5 millions
Number of boats	12,628 boats 261,868 net tons
Number of fishermen employed	51,550
of whom	45,897 regular
	5,653 occasional

Source *Statistical Abstract for the U K* 1924-37, Tables 223 and 224

(*b*) *U S* 1941

Total output of fisheries*	41 0 million cwt.
Value of output	$116 7 millions
Number of fishing vessels	5,597
Number of boats	65,126
Number of fishermen employed	122,069

* Types of fish included are not stated

Source *Statistical Abstract* 1943, Table 792

(*c*) *Productivity*

Index U K = 100

Output ratio	U S U K	188
Employment ratio	U S U K	237
U S output per head		79*

* This does not allow for shell fish output in the U K

APPENDIX 34

FUEL AND POWER AND MINING

A. COAL MINING

I. COMPARATIVE DATA

The following figures are based on the *Report of the Technical Advisory Committee on Coal Mining*, known as the Reid Report.

Table 157 *Output per man-shift in U K , U S. and German mining, in tons*

	U K	U S (bituminous coal mines)	Germany: Ruhr	Germany: Upper Silesia	Germany: Saar	U K -U S ratio U K.=100
		Output per man-shift				
1913	1 016*	3 22	0 930	1 131†	0 790	317
1925	0 901	4 04	0 931	1 135	0 669	448
1935	1 168	4 02	1 665	1 782	0 914‡	344
1937	1 168	4 19	1 600	1 900	1 037	358
1938	1 148	4 37	1 523	1 830	1 121	381

* June, 1914
† Including East Upper Silesia
‡ March-December Average

(See the Reid Report, *Coal Mining Report of the Technical Advisory Committee*, Cmd. 6610, London, H M Stationery Office, 1945, Appendix I, p 141)

B. FUEL PRODUCTION

Table 158. *Output, employment and productivity in U K and U.S. fuel production*

(*a*) *Number of persons employed in the U S , 1939**

Type of fuel produced	Total persons employed	No of operatives employed
(1) Crude petroleum and natural gas	141,592	105,166
(2) Natural gasoline	10,347	8,332
(3) Bituminous coal	393,308	369,156
(4) Lignite	1,739	1,480
(5) Pa anthracite	88,520	82,822
(6) Total (1)-(5)	635,506*	566,956
(7) Water-power	90,000	83,000
(8) Total (6)+(7) approx	725,000	650,000

* Does not include contract services for oil and gas fields

Source Rows (1)-(5) Table number 803 of *Statistical Abstract of the United States*, 1943 Row (7) estimated on basis of Table 479, op cit , on the assumption that waterpower is used to generate electricity and that just under one-third of the persons employed produce a little over one-third of the output This latter proportion is shown as generated by water-power.

Table 158

(b) Output of energy from mineral fuels and water-power in the U S, 1939

	Million tons of 2,000 lb	Million tons of 2,240 lb
Equivalent in bituminous coal	932*	832

* Excluding imported oil (7 6 million short tons)
Source Table 470, op cit

(c) Output and employment in British coal mines in 1939

	Output (million tons)	Average no of wage-earners on colliery books
U K, 1939	231 3	766,300

Source Ministry of Fuel and Power, *Statistical Digest from* 1938, Cmd 6538, London, H M. Stationery Office, 1944, Coal, Table I

(d) Productivity comparison, U K -U S

	U K =100
Output of energy	360
Number of operatives	85
Output per operative*	423

* No allowances have been made for differences in average hours worked

C. IRON ORE MINING

Table 159. *Output, employment and productivity in U.K. and U.S. iron ore mining*

(a) Output and employment in the U K.

	Iron ore and ironstone raised (million tons)	Iron contained in iron ore and ironstone raised (million tons)	No of persons employed	Average hours worked per week
1935	10 9	3 3	7,981	45 4
1937	14 2	4 3	9,663	
1938	11 9	3 6	9,341	41 2

(b) Output and employment in U S 1939

	Crude ore* (million tons)	Merchantable ore (million tons)	Iron contained in merchantable ore (million tons)	Average no of men employed
1939	57 4	51 7	26 0	21·859

* Partly estimated

Table 159 (c) *Comparative productivity**

	U K (1935)	U K (1938)	U S (1939)	
			Crude ore	Merchantable ore
Output of iron ore per worker				
Tons	1,366	1,274	2,626	2,365
Index		100	206	186
Output of iron contained in the ore per worker				
Tons	413	385	1,189	
Index		100	309	
Output of iron ore per man-hour				
Tons	0 58†	0 59†	1 469	1 325‡
Index		100	249	225
Output of iron contained in the ore per man-hour				
Tons		0 18	0 666	
Index		100	370	

* The U K figure includes a small number of salaried persons

† Calculated by dividing the annual output by 52 It may therefore be slightly under-estimated

‡ Corresponding U S figure for 1938, 0 929 Index U K =100, U S =157

Sources U K *Annual Report of the Secretary for Mines*, 1938, Tables 38 and 13 For hours of work, *Ministry of Labour Gazette*, February 1945 and May 1937 U S *Minerals Year Book*, 1940, p 551

D. MINING (other than fuel and iron ore)

Table 160. *Output, employment and productivity in U.K. and U.S. mining, other than fuel and iron ore*

(a) *U.S* 1939

Total number of employees		220,277	
Value of output	$ mill.	886	
Value of net output*	$ mill	731	
Gross output per head	$	4,027	(£908)†
Net output per head	$	3,321	(£749)†

* The value of supplies and materials, fuel, purchased electric energy and contract work deducted from the value of output

† Converted at the official rate of £1 = $4 435

Source *Census of Mineral Industries*, 1939 Quoted from *Statistical Abstract of the United States, 1944-5*, Table 833

(b) *U K.* 1935*

Total number of employees	70,067
Value of gross output	£17 4 million
Value of net output	£13 4 million
Gross output per head	£248
Net output per head	£191

* Mines and quarries, excluding coal mines and metalliferous mines and quarries It is not possible to separate iron mines in the latter category, but iron mines account in any case for the bulk of output and employment

Source *Census of Production, 1935*

(c) *Comparative productivity*

	U K = 100
U S gross output per head	366
U S net output per head	392

APPENDIX 35

PUBLIC UTILITIES AND COMMUNICATIONS

I. CONSIDERATIONS AFFECTING PRODUCTIVITY COMPARISONS

A comparison of productivity in these industries is necessarily less exact than comparisons in manufacturing industries In most cases output can be defined only in physical terms, for example, gas produced, electricity generated, messages forwarded, and the very substantial 'service' element will be neglected.

There are further difficulties in almost all cases, arising from the fact that much of the activities of the workers in these industries consists of maintenance, repair, and new construction of gas pipes, electric cables, etc.

Specific complications arise in the gas industry, as the British industry produces and distributes the total output, whereas the U.S. industry produces and distributes manufactured gas and also distributes part of the natural gas.

In the communications industries specific difficulties arise from differences in the relative importance of single output items, such as letters, telephone calls and telegrams Moreover the manifold 'other' activities of Post Offices have to be neglected in both countries, and there is no reason to assume that they are identical in scope or importance.

II. COMPARATIVE DATA

A. THE GAS INDUSTRY

Table 161. *Output and employment in the U.K. and U.S gas industries*

(*a*) *U.K* 1935

	Quantity	Value
Total output of gas (including gas used in own works)	309,371 million cubic feet	—
Gas sold	299,470 ,, ,, ,,	£49 million
Gas coke and breeze	7,753 thousand tons	£9 ,,
Work charged to consumers	—	£3 ,,
Other by-products	—	£4 ,,
Total gross output		£65 ,,
Net output		£40 ,,
Number of consumers	10 5 millions	
Average number of persons employed	121,249	
Number of operatives	96,524	

Table 161 (*b*) *U.S* *

	1935	1939	1941
(*a*) Manufactured gas industry			
Gas produced	232,029	240,297	271,252
Gas purchased†	128,100	146,217	161,897
Gas produced and purchased	360,129	386,514	433,149
Total gas sales to consumers†	325,061	358,683	403,819
Number of customers‡	9,354	9,920	10,368
Number of employees	67,100	66,700	67,600
(*b*) Natural gas industry			
Total gas sales to consumers	1,057,573	1,332,299	1,607,911
Number of customers	6,718	7,584	8,253
Number of employees	—	—	71,300

* Number of customers in thousands, gas in millions of cubic feet
† Partly natural, partly by-product coke-oven gas sold as manufactured gas
‡ Including data for the miscellaneous group not separately shown
Sources U K *Census of Production* and *Statistical Abstract, 1924-37*, Table 240 U S. *Statistical Abstract, 1943*, Tables 841-3

Table 162 *Productivity comparison in the U.K. and U S gas industries*

(*a*)

Index U K = 100

	U S (1939)
Ratio of output*	90-95
Ratio of employment	55†
Ratio of output per head	163-173

* This figure has been obtained in the following way The U K gas industry both distributes *and* manufactures the whole output, and statistics for 1939 show that 39% of all persons are employed on distribution As the U S only *distributes* natural gas, one way of adjusting output is to add a proportion only, of 'gas purchased' to 'gas produced' If the 39% for the U K applies equally to the U S , we arrive at a total which can be regarded as the equivalent of gas produced and distributed for both countries, by adding 39% of the amount purchased to the amount produced In this way, and by making a small allowance for the higher amount of by-products in the U S , the output index can be put at 90-95 (U K = 100) as given above
† No adjustments have been made for workers engaged on construction, repair, etc

The total amount of gas sales in the U S. to the public of both natural and manufactured gas amounted to 2,011,730 million cubic feet and the total number of employees to 138,900 in 1941. (See Table 161 (*b*)) When comparing the total amount of gas sold to consumers, we get the following:

(*b*)

	U K	U S
Gas sold (cubic feet) per employee	2 5 million	14 5 million
Index	100	580

B. ELECTRICITY SUPPLY AND DISTRIBUTION

Table 163 *Output, employment and productivity in U K and U S electricity supply and distribution*

(*a*) *U K* 1937-8*

Output of units generated	23 011 million units
Employment Total number of employees	103,531†
of which	
Engaged in generation	18,402
Engaged in distribution	59,760
Engaged in administration	25,369

Table 163 (*b*) *U S* 1937

Output reported as generated‡	121,097 million kw hours
Output reported as sold	132,930 million kw. hours
Employment Total number of employees, at 30 June	281,335

(*c*) *Index of U K and U S productivity*

Index U K = 100

Ratio of output generated	526
Ratio of employment	272
Output per head	193

* The above data relate to authorized undertakings not including railway and tramway companies relying on their own sources of generation, nor private generating activities of collieries and other industrial and commercial organizations for their own use, and they exclude cases in which public supplies of electricity are given by undertakings established without statutory powers

† In connection with electricity generation and distribution charged to revenue account

‡ Total output in 1937 was 168,000 million kilowatt-hours, comprising 'generated' energy and 47,202 million kilowatt-hours 'purchased and received from other sources' Since the latter item was in a large part purchased from other electric light and power companies, considerable duplication is involved, as such energy would also be included in the 'generated' It has therefore been excluded

Sources U K Electricity Commission *Electric Supply Return for* 1937-8, p 35 and p. 126 U S *Statistical Abstract*, 1943, Table 479

C. COMMUNICATIONS

(Post, telegraph, telephone)

Table 164. *Output and employment in the U K and U.S. post, telegraph and telephone services*

(*a*) *U K* 1937-8

	Million	
Letters, etc delivered	7,990	
Parcels handled	179 5	
Registered letters	49 8	
Cash-on-delivery parcels	3 0	
Air mail letters	40 3	
Total 'mail' etc handled	8,262 6	
Number of money orders issued	14 7	412 4
Issued in U K for payment abroad	0 5	
Issued abroad for payment in U K	1 7	
Number of postal orders issued	395 5	
Telegrams	71 1	
Telephone stations	3	
Telephone calls	2,167 0	
(trunk)	(107 0)	
Wireless licences issued during the year	8 6	
Staff (P T T)		278,995 persons

Source Statistical Abstract for the United Kingdom, 1924-37, Tables 242-246

Table 164 (b) U S 1937

(a) Post Office			Million
Number of pieces of mail handled			25 801
Money orders issued, 1940			
Domestic		255	258
International Issued		2	
Paid		1	
Employment in P O in 1937			284,316 persons
June 1943			315,857 ,,
(b) Telephone system (1937)			Million
Number of telephones			19 5
Number of calls			33 618
Employees			333,162
(c) Wire telegraph system (1937)			Million
Number of messages			218 1
Number of employees 30 June			73,457
31 December			69,737
(d) Estimated employment in 1937 in the post office, telephone system and wire telegraph system			690,900

Source *Statistical Abstract*, 1943, Tables 450, 457, 461, 462, 464

Table 165. *Productivity comparisons in the U K. and U S. post, telegraph and telephone services**

(i) *Comparison of output*, 1937

(index numbers, U.K = 100)

	U K	U S
Mail handled	100	310
Postal orders handled	100	60
Phone calls made	100	1,550
Telegrams sent	100	650
Output weighted by revenue per unit of output†		
U K weights	100	757
U S weights	100	588

(ii) *Comparison of employment*, 1937

	U K	U S
Total employment	100	250

(iii) *Comparison of output per head*, 1937

	U K	U S
Output per head		
U K weights	100	303
U S weights	100	235

* This comparison ignores the great many other activities carried out by the postal, telephone and telegraph services Differences may be caused by the different amount of construction work in connection with telephones

† Revenues per unit of output compare as follows

	U K	U S
	1936-7 (in pence)	1937 (in cents)
Mail	1 45	2 77
Telegrams	13 5	6 92
Telephone calls	3 72	3 51

APPENDIX 36

TRANSPORT

The tentative productivity comparisons of Chapter VI are based on the data given in the tables below.

Tables 166 and 167 present the data for railways, Table 168 for motor buses, Table 169 for tramways and light railways, Table 178 summarizes comparative data for the road haulage industry, and Tables 179 and 180 indicate the estimated employment in all transport activities of the U K. and U.S.

A. RAILWAYS

Table 166 *Output and employment in U K , U S. and German railways*

	U K (1937)	U S (1936-40)	Germany (1937)
(1) Number of persons carried (millions)	1,295	469	1,808
(2) Freight traffic carried (million tons—2,240 lb)	318	831	491
(3) Passenger miles (number of passengers multiplied by the average length of journey) (millions)	22,370	23,065	31,130
(4) Net ton-miles (freight tons carried multiplied by the average length of haul) (millions)	18,384	302,733	48,775
(5) Passenger train miles (millions)	283	399	—
(6) Freight train miles (millions)	140	469	—
(7) Coach miles (millions)	2,120†	2,982	—
(8) Wagon miles‡ (millions)	4,843	22,125	—
(9) Average length of journey (miles)	17 27*	49 18	—
(10) Average length of haul (miles)	57 86	364 30	—
(11) Revenue per passenger mile	0 80d	1 82 cents	—
(12) Revenue per freight ton-mile	1 31d.	0 96 cents	—
(13) Employees ('000)	580§	1,115	704

* September 1934 See Ministry of Transport, *Railway Returns*, 1938

† Estimate on the basis of 7 5 cars per train as in the U S

‡ Including empty wagons

§ Based on Railway Companies (Staff) Returns, 1938 The total number of employees on 13 March 1937 was 599,652 (on 12 March 1938 it was 607,278) Most employees in ancillary activities (hotels, ports, canals, etc , etc) were deducted

Employees of railway shops appear to be included in both countries' figures Total employment in British railway shops according to the *Census of Production* amounted to 211,219 persons in 1935, who were engaged on work of maintenance, repair, and construction Of these activities, only construction of new rolling stock is a 'manufacturing activity', absorbing approximately half the total number of railway shop employees

On the basis of the *Census of Production* it can also be estimated that two-thirds of new locomotives and wagons, and three-quarters of all carriages produced for home demand of the railways came from railway shops

In the U S the total number of persons employed in railroad shops amounted to 155,000 in 1935 According to the *Census of Manufactures* about one-quarter of all locomotives and about one-tenth of all cars and car equipment (by value) was produced in railroad shops

A further consideration is that terminal operations in the U K are very high (e g delivery and collection). This does not apply to the U S Persons engaged in those operations are counted as railway employees and to this extent the picture for the U K would appear less favourable than it actually is

Sources U K *Statistical Abstract*, 1924-37, Tables 252-3 and Ministry of Transport *Railway Returns*, 1938, Table A1 (*a*)

U S *Statistical Abstract*, 1943, Tables 513-16 (steam railways including their electrical divisions) Data refer to Class 1 companies, with more than $1 million annual revenue Practically all companies fall into this category

German *Statistiches Jahrbuch fur das Deutsche Reich*, 1938, 'Eisenbahnverkehrs und Betriebsergebnisse' (in the international section)

Table 167 *Productivity comparisons in U K, U.S. and German railways,* 1937

(a) *Ratios* (1937)

	U K	U S	Germany
Employment	100	192	121
Passenger miles	100	103	139
Net ton-miles	100	1,647	265
Passenger train miles	100	141	—
Freight train miles	100	335	—
Car miles*	100	360	—
Passenger miles and net ton-miles combined and weighted by average revenue			
By U K average revenue	100	989	—
By U S average revenue	100	570	—

* Unweighted total of coach and wagon miles

(b) *Output per employee*

(i) *Passenger* and *net tone-miles* weighted by *gross revenue** coming from passenger and freight traffic respectively in 1937

	U K	U S	Germany
Output per employee.			
U K weights	100	504	174
U S weights	100	762	—
German weights	100	—	190

(ii) *Passenger* and *net ton-miles* weighted by *average revenue* (see Table 166)

	U K.	U S
Output per employee weighted by		
U K average revenue	100	515
U S. average revenue	100	297

(iii) *Train miles* (passenger and freight) weighted by *gross revenue* *

	U K	U S
Output per employee		
U K weights	100	130
U S. weights	100	163

* See note at foot of table, p 240

Table 167 (*b*)

(iv) Car miles (unweighted total of coach and wagon miles)

	U K	U S
Output per employee	100	188

(v) Passengers and *freight traffic* carried Weighted by *revenue per unit* (per passenger or ton carried)

	U K	U S
Output ratio		
U K weights	100	161
U S weights	100	154
Output per employee		
U K weights	100	84
U S weights	100	80

* In the U K 44% of the revenue came from passenger traffic and 56% from freight traffic, in the U S 12% and 88% respectively, and in Germany 29% and 71% respectively

B. MOTOR BUS LINES

Table 168. *Output, employment and productivity in U K and U.S. motor bus lines*

(*a*) *Great Britain* 1937

Vehicles owned	49,574
Passenger journeys (millions)	6,664
Vehicles mileage (millions)	1,462
Employment (total number)	245,000*
	295,000†

* Based on S.M M T estimate p 51, see source below

† Based on London Passenger Transport Board experience.

Sources Seventh Annual Report of the Traffic Commissioners, 1937-8; also Society of Motor Manufacturers and Traders, *The Motor Industry of Great Britain*, 1939, p 95

(*b*) *U S.* 1937

(i) Public carrier revenue operations

Number of buses	51,500
Revenue passengers (millions)	3,293
Revenue bus miles* (millions)	1,888
Employment (total number)	112,239

(ii) Private carrier non-revenue operations

Number of school and other buses operated	79,100
Passengers carried (millions)	656
Estimated number in employment	79,100

otal bus miles are probably double that amount

Source Statistical Abstract, 1943, Table 536

Table 168 (*c*) *Comparisons**

Index U K =100

	U K	U S
Employment†	100	46
Passengers	100	49
Bus miles	100	129
Passenger journey per employee	100	107
Bus miles per employee	100	280

* Revenue operations only
† There may be differences in the scope of the employment data

C. TRAMWAYS AND LIGHT RAILWAYS

Table 169. *Output, employment and productivity in U.K and U S. tramways and light railways*

(*a*) *U K*

Output	Passenger journeys (millions)	Vehicles	Vehicle miles (millions)	Miles of line operated
Trams, 1936-7	3 379	9,803	301	1,341
Trolleys, 1936-7	632	1,950	62	538
Light railways, 1936-7	450	3,154	168	174
	4 461	14,907	531	2,053

Employment	Passenger journeys (millions)
L P T B railways	15 251
Estimated for all trams and trolleys	87 600*
Estimated total employment	102 851

* Based on London Passenger Transport Board experience, disregarding those common to all services and without making allowances for construction workers

Sources *Statistical Abstract for the United Kingdom*, 1924-37, Table 258, and London Passenger Transport Board *Annual Reports*

(*b*) *U S.* 1937

Electrical railways (main companies)

Miles of line operated	Vehicles	Revenue passengers (million)	Vehicle miles (million)*
14,214	44,864	7,485	1,490
No of employees 152·476			

* Assuming that the average mileage per vehicle is the same as in the U K·
Source *Statistical Abstract*, 1943, Table 527

CP

Table 169. (*c*) *Comparisons*

U K = 100	
Employment in U S	148
Passengers in U S	167
Estimated vehicle miles in U S.	281
Estimated passengers per employee	113
Estimated vehicle miles per employee	190

D. BASIC DATA ON ROAD TRANSPORT

Table 170. *Employment and vehicles in use in U.K. and U.S. road transport*

(*a*)

Estimated number of persons employed, U K	1939
Public service vehicle (bus) operation	245,000
Taxi-cab and hire car operation	25,000
Goods transport for public service	220,000
Goods transport for ancillary use	340,000
Chauffeurs	40,000
Road construction and maintenance	100,000
Garage operation and sales	150,000

Source *The Motor Industry of Great Britain*, op cit , 1939, p 51

(*b*)

Vehicles in use, U.K.	September 1937	September 1938
Private cars	1,834,248	1,984,430
Trucks	487,750	504,028
Coaches and buses	51,568	53,609
Taxis	35,906	35,801
Exempt vehicles (mostly Government-owned, road rollers, fire-engine, ambulances, etc)	49,446	63,336

Source *The Motor Industry of Great Britain*, op cit 1939, p 63, Official registrations.

(*c*)

Persons employed, U S	1938
Bus drivers*	177,905
Truck drivers†	3,544,956
Federal and State road‡	267,734
Sales and servicing	1,163,886

* Estimated by allowing 2 drivers per revenue bus—1 driver per school bus.
† Estimated by allowing 1 14 full-time drivers per truck, exclusive of farm trucks
‡ Employment on country and township roads is not available

Source. Automobile Facts and Figures, issued yearly by the Automobile Manufacturers' Association, Inc., 1939, p 47

Table 170 (*d*)

Vehicles in use, U S	31 December 1938
Passenger cars	25,151,311
(Passenger cars on farms included in above)	(4,516,508)
Buses	132,002
(Non-revenue buses, i e school buses, etc, included in above)*	(81,100)
Trucks	4,202,367
(Farm trucks included in above)	(997,127)
Tax-exempt official cars	367,230

* About 6,000 buses in school service operate part-time as common carriers and consequently are included in the figure for that service

Source *Automobile Facts and Figures*, op cit 1939, pp 16, 21, 72, 80

Table 171 *Inter-city goods traffic conveyed by different means of transport*, 1936 (*U K*)

	(1) Tonnage ('000 tons)	(2) Ton-miles (million)
Rail	280,712	17 430
Road	100,000	(10 000)†
Coastwise	23,287	
Canal	14,235	

† Estimate Road transport carries mainly 'general merchandise' and the average rail haulage of such merchandise was 104 miles in 1935 and 106 miles in 1936 The estimate of 10,000 million ton-miles would correspond to an average truck-load of nearly three tons, on the assumption that 120,000 trucks were employed in the long-distance service, each doing an average of 32,000 miles annually (twice the average truck mileage) Road tonnage is Mr Walker's estimate

Source Gilbert Walker, *Road and Rail*, London, Allen & Unwin, 1942, p 16

Table 172 *Passenger traffic conveyed by different means of transport*, 1937 (*U K*)

	Total passenger miles (millions)	No of long-distance passenger miles
(1) Rail, 1937	22,370	22,370
(2) Bus, 1937	16,800	—
(3) Trams, trolley and tube	6,384	—
(4) Private cars	29,360	18,000

Sources (1) Based on railway returns See table

(2) Car miles multiplied by 11 5 passengers, see Motor Vehicle Operations, *The Motor Industry of Great Britain*, op cit p 94

(3) Car miles multiplied by 12 passengers, as given for trolleys in *The Motor Industry of Great Britain* (Motor Vehicle Operations), op cit p 94 The same number of passengers for trams and tube-cars is assumed

(4) The number of private cars in 1937 (1,835,000) multiplied by estimated annual average length of 8,000 miles and multiplied by 2, the estimated average number of passengers (see Motor Vehicle Operations) As in the U S the average mileage is also approximately the same, i e 8,870 miles per annum of which 2,680 is in the streets, it may be assumed that the position is not unsimilar in this country Based on *Automobile Facts and Figures*

Table 173. *Estimated inland inter-city freight traffic by type of carrier, 1939 (U.S.)*

	Freight ton-miles (millions)	%	Freight in tons (millions)
Railways	336,100	62·2	955
Inland waterways	96,249	17·8	
Great lakes	76,312		
Rivers and canals	19,937		
Petroleum trunk pipe-lines	65,015*	12·0	
Highways†	43,100	8·0	1,725 or 1,231
Airways	11	—	
Total	540,375	100·0	2,186-2,680

* Estimates

† Half hired trucks, half owned trucks

Source Interstate Commerce Commission, *Annual Report*, 1940, p. 23. See also National Resources Planning Board, *Transportation and National Policy*, 1942, p. 33.

Table 174. *Estimated inland inter-city passenger traffic by type of carrier, 1939 (U.S.)*

	Passenger miles (million)	%
Railways	23,669	8·7
Inland waterways	1,486	0·6
Highways*	245,891	90·5
Airways	678	0·2
	271,724	100·0

* Including estimated passenger miles in private cars, of the 90·5%, private cars account for 85·4%, the rest are accounted for by buses.

Table 175. *U.K. road haulage industry*

	U.K. June 1937
(1) Class A licence (general haulier) Vehicles authorized	91,101
Class B licence (for hire carrying own goods) Vehicles authorized	53,775
Class C licence (private traders carrying own goods) Vehicles authorized	362,380
	507,256
(2) Vehicles operating in long-distance service	110,000-120,000

Sources For (1), *The Motor Industry of Great Britain*, op. cit., 1939, p. 94. For (2), Gilbert Walker, op. cit., p. 22.

U.S. road haulage industry

Two sets of data are available on road haulage in the U S. and these are somewhat contradictory.

(A)

(i) The number of vehicles has been ascertained by a nation-wide truck and bus inventory carried out in 1941 by the Public Roads Administration

(ii) The total number of persons employed in the trucking service and warehousing in 1940 as shown by the *Census* was 488,816.

Table 176. *U.S. road haulage industry* (1941)

(a) Number of vehicles

	Publicly owned	Private, not for hire	Private, for hire: Local haul	Private, for hire: Other	Private, for hire: Total	All vehicles
Trucks	139,114	2,935,607	358,215	278,201	636,416	3,711,137
Truck tractors	1,127	49,269	7,775	63,085	70,860	121,256
Semi-trailers	1,649	61,852	8,432	66,903	75,335	138,816
Trailers	2,438	17,911	1,976	8,092	10,068	30,417

(b) Annual average mileage

Trucks	11,100	9,400	10,800	approx 14,600	12,500	
Truck tractors	10,900	25,100	17,980	36,200	34,400	

Source *Statistical Abstract*, 1943, Tables 128, 495-6

(B)

Table 177 *Operating statistics of Class I inter-city motor carriers of property in the U S*

(i e companies with $100,000 or more operating revenue)

	1941
Inter-city vehicle miles (owned and leased vehicles) (millions)	2,121
Miles per owned vehicle	49,514
Approximate number of vehicles operating	42,800
Tons of inter-city revenue freight carried (with duplication) (millions)	76 5
Estimated number of persons employed (approx)	100,000

Source Based on *Statistical Abstract*, 1943, No 533

The number of trucks employed in U S inter-city traffic has been put at about 400,000 owned by the haulage industry, together with 400,000 that are owned by private firms

The number of persons employed in inter-city traffic can be estimated as follows.

(i) On the basis of the data given in A, at about 250,000 persons for the inter-city haulage industry

(ii) On the basis of the data given in B, the number of persons employed in the inter-city haulage industry is about 1,000,000.

(iii) To reach the total number employed in inter-city traffic, the numbers engaged in driving the cars of private firms must be added. The basis here is 1·14 driver per car, which yields as the total thus employed 450,000

(iv) Thus the total employed on basis A is

250,000+450,000=700,000 persons

and on basis B it is

1,000,000+450,000=1,450,000 persons.

Table 178 *Comparisons of the U K and U S road haulage industries**

	Vehicle miles (millions)	Freight tons (millions)	Freight ton-miles (millions)	No of persons employed
U S All road haulage industry	—	(1,200-1,700)	43,100	(700,000-1,450,000)
U S Inter-city carriers	2,121	76‡		about 100,000
U K	(3,840)§	100	(10,000)	150,000-180,000†

* This is a highly conjectural comparison

† The road haulage industry having 145,000 vehicles on A and B licences employs 220,000 persons, i e 1½ persons per vehicle Thus 120,000 vehicles operating on long-distance traffic would correspond to 180,000 persons Class C licence vehicles however need a smaller number of persons

‡ With duplication

§ 120 000 vehicles times 32,000 miles

Table 179 *Estimated employment in the U K transport industry*

	1937-8
(1) Railways (less ancillary activities)	580,000
(2) Trams, etc	85,000*
(3) Buses	245,000
(4) Taxis	25,000
(5) Chauffeurs	40,000
(6) Goods for public services	220,000
(7)-(8) Goods for ancillary use	
Long distance	60,000
Otherwise	280,000
(9) Road, construction and maintenance	100,000
(10) Garage operations and sales	150,000
(11) Coastal shipping	21,500
(12) Merchant Navy	110,800
(13) Docks, harbours (say)	166,000
(14) Canals	—
(15) Air (say)	2,000
Total (approximately)	2,100,000

* Excluding London Passenger Transport Board's railways, included in railways

Sources See previous tables in this Appendix For rows (11)-(12) *Statistical Abstract for the United Kingdom*, row (13) Unemployment statistics, *Statistical Abstract*

Table 180. *Estimated employment in the U.S. transport industry*

	Employed 1940 ('000)
(1) Railways (including railroad shops)	1,100,000
(2) Railway express service	35,000
(3) Street railway and bus	203,000
(4) Trucking service and warehousing	489,000
(5) Water transport	181,000
(5*a*) (No included in Merchant Service)	(51,000)
(6) Petroleum etc pipelines	18,000
(7) Air	23,000
(8) Taxi-cab	84,000
(9) Services incidental to transport	29,000
(10) Not specified	16,000
(11) Estimated road haulage, long distance, private firms	450,000
(12) Transport personnel employed by distribution, service, construction and manufacturing not included in previous rows	2,400,000
(13) Docks, harbours etc (probably included in water transport)	
(14) Roads	267,000
(15) Sales and servicing	1,164,000
(16) Chauffeurs (say)	120,000
Total (approximately)	6,600,000

Sources *Statistical Abstract for the United States* and material given in this Appendix.

APPENDIX 37

SERVICE INDUSTRIES

Table 181 *Estimated employment in specified service industries in Great Britain*, 1939

Service industries, professions and Government	No of persons employed (000's)
Hotel industry	645
Laundry and dry-cleaning industry	212
Entertainments industry, approximately	150
Repair industry (except motor repairs), approximately	300-400
Domestic service, approximately	1,400
Professional services	440
Government service	1,100
Total	4,300-4,400

Note. It should be noted that the range of employment differs slightly from the range of services included in output (see p 88) The following are the main items covered in the output data entertainments, laundry, dry cleaning, repairs (except repairs to houses and motor vehicles), barber shops and beauty parlours, domestic servants, health care and burial expenses, legal services chargeable to consumption, private education, insurance, etc. See *The Impact of the War on Civilian Consumption*, op cit, p 134

Sources The Impact of the War on Civilian Consumption, Combined Production and Resources Board, London, H M Stationery Office, 1945, and the 1931 *Census of Population*.

Table 182 *Estimated employment in specified service industries in the U S*, 1940

	000's
Personal services (domestic, hotels, laundry, others)	4,009
Repairs excluding motor repairs	385
Amusements	395
Professional (excluding Government employees in the field of education and health), approximately	1,800-2,000
Eating and drinking places	1,116
Total	7,700-7,900
Government	3,100-3,300
Total services and Government	11,000

Note See note to previous table
Source Statistical Abstract, 1943, Table 128.

BIBLIOGRAPHICAL AND STATISTICAL NOTE TO CHAPTER IV

Statistical sources on changes in productivity of labour in U.K. and U.S. manufacturing industry

Chapter IV summarizes the available information on changes in the productivity of British industry in the period 1907-38. Unfortunately this information is extremely scanty, and the need for a thorough systematic study of the subject, based on the primary sources of statistics, is clearly indicated.

The main difficulty is the lack of reliable, comparable and sufficiently detailed indices of production. No attempt has been made in Chapter IV to calculate new indices of production—a major task in itself—and all the indices of production used were taken over (and if necessary adjusted) from other studies. The computation of employment indices is less difficult—especially for years for which either *Census* information or social insurance statistics, or both, are available. In relating output indices to employment (or total man-hours) indices the scope of activities covered by the two indices is, of course, a problem of its own.

Prior to the first British *Census of Production*, 1907, long-period changes in the volume of industrial production were estimated by DR W. HOFFMAN back to 1713 in his study 'Ein Index der industriellen Produktion fuer Grossbrittannien seit dem 18. Jahrhundert', *Weltwirtschaftliches Archiv*, September 1934. On the basis of his figures and using *Census of Population* data on numbers of occupied persons in industry, COLIN CLARK estimated the changes in productivity for the 1837-45 to 1908-14 period. (See C. Clark, *The Conditions of Economic Progress*, London, Macmillan, 1944, p. 289.)

For the 1907-37 period with which we are concerned in Chapter IV, we have a great deal more primary information in the full *Censuses* of 1907, 1924, 1930 and 1935, in the incomplete *Census* of 1912 and in the Import Duties Act Inquiries of 1933, 1934 and 1937 (the last one only partly tabulated and published) as well as in many other sources of official and unofficial information.

For the 1907-24 period indices of production, employment and output per head, for industry as a whole and for the major groups of industries, have been calculated by N. A. TOLLES and P. H. DOUGLAS, in their article 'Measurement of British Industrial Production', *The Journal of Political Economy*, Vol. 38, 1930, p. 28, based on *Census* information. Their index of production is a Fisher type of index, using double weighting of both years. In making up indices of groups the sales values have been used as weights between different commodities in the same industry, while net output values were used for weights between different industries.

For the 1924-35 period the same information (on production employment and productivity) is available for industry as a whole and for the main industry groups, in three sources, all three based on provisional *Census* reports. There are the estimates of MR E. C. RHODES in the *Special Memorandum No* 47

of the *London and Cambridge Economic Service**; this study forms the basis, to a certain extent, of the estimates of PROFESSOR A L. BOWLEY, *Studies in the National Income*, N I E S R. Study No. I, Cambridge, 1944, p. 136 An alternative estimate has been made by MR. E DEVONS 'Production Trends in the United Kingdom, *The Manchester School*, Vol. X, 1939, p. 55. The basic difference between the two estimates is that RHODES and BOWLEY assume that for an industry where output is returned partly by quantity and value and partly by value only, the quantity changes ascertained for the first part are also representative for the second part, while DEVONS assumes that the average price changes of the first part are representative of price changes of the second part (For discussion of the controversy see the sources quoted) Both alternative indices are double weighted.

For the 1924-30 period there is a third source of information, for industry as a whole and for the main groups of industry, and for selected individual industries, in the *Final Report*, Part V, of the 1930 *Census of Production*. This is a single weighted index, i e 1924 quantities are revalued at 1930 prices (See Chapters III and IV of *Final Report*, Part V, and Bowley, op. cit p. 136.)

For the 1924-35 period, indices of production for the principal products of individual industries are available in the *Final Reports* of the 1935 *Census of Production*, which are again single-weighted indices based on 1935 average values.

For the 1924-38 period (for each year except 1925 and 1926) a critical review and comparison of available indices of production for industry as a whole and for the main groups (i.e. the London and Cambridge Economic Service annual and quarterly index, the Board of Trade index, and the *Census of Production* index for censal years) is given as well as a new series of output indices suggested and an index of employment (based on social insurance statistics) computed by MR STONE (See STONE, R. and W. M., 'Indices of Industrial Production', *The Economic Journal*, Vol. 49, 1939, p. 476.) The reliability of the London and Cambridge Economic Service index of production for the same period is discussed by PROFESSOR BOWLEY (op. cit pp. 151-3)

For purposes of Chapter IV output indices given by Tolles and Douglas, Devons and Stone were used for the main industry groups, and the 1935 *Census* indices for the individual industries Employment indices were computed in most of the cases straight from the *Census* information Data on actual hours of work were taken from the official Earnings and Hours Inquiries. It is obvious that the combined use of several indices of production based on different formulæ and assumptions as well as the use of employment indices which do not cover, strictly speaking, the same range of activities as the output figures† will give output per employment and output per man-hour indices which are by no means accurate estimates and which should be regarded only as broad indications of the trend

A more serious problem arises in the case of individual industries. Output indices are based on Table V of the 1935 *Census*, 'Output of principal pro-

*London, August 1938

† For the main industry groups, for example, output indices are based on provisional *Census* data, while employment indices are based on final data

ducts', which includes output recorded by firms whose returns were made on schedules for other trades, but excludes 'other output', i.e. either output of principal products of other trades or output of smaller products or by-products of the same trade Employment indices however are necessarily based on the total activity of the firms comprised in that particular industry, thus covering the output of principal products produced in the trade, including the output of 'other products', but excluding that part of the output of the principal products which is produced by firms in other trades By relating employment indices thus arrived at to the output indices given in the *Census* we virtually make the assumption that the ratio of 'carry-in' products and of 'carry-out' products to the principal products in the trade is the same in all years under review.* A further shortcoming of the output indices is the use of average values, which thus makes no allowances for quality changes. Lastly they do not allow for changes in integration in the several industries.

For the U S virtually complete information is available on long-term changes in production, employment and productivity (output per wage-earner and man-hour) The two main sources of information are

(1) The fundamental studies of S FABRICANT, of the National Bureau of Economic Research, published in the following two books

Output in Manufacturing Industries, 1899-1937, New York, N B E R., 1940, and *Employment in Manufacturing*, 1899-1939: *An Analysis of Its Relation to the Volume of Production*, New York, N B.E R , 1942

(2) The continuous studies of the Productivity and Technological Development Division, Bureau of Labor Statistics, United States Department of Labor. Of their many publications, the following ones are of particular importance:

Productivity and Unit Labor Cost in Selected Manufacturing Industries, 1919-1940, February 1942 (mimeographed), *Productivity and Unit Labor Cost in Selected Manufacturing Industries*, 1939-1945, May 1946 (mimeographed).

The basic study underlying the Bureau of Labor Statistics' indices was undertaken in the 'thirties by the National Research Project on Re-employment Opportunities and Recent Changes in Industrial Techniques, a unit of the Works Progress Administration directed by DAVID WEINTRAUB The result of their work is a three-volume report, *Production, Employment and Productivity in* 59 *Manufacturing Industries*, 1919-1936, prepared by HARRY MAGDOFF, IRVING H SIEGEL and MILTON B DAVIS, which gives indices of production, employment and productivity. The Productivity and Technological Development Division of the Bureau of Labor Statistics has made some revisions in these indices and extended most of them for further years, and has calculated indices of pay rolls and unit labour costs

* The final Report of the 1930 *Census* (in Appendix 2) has estimated the differences between the two indexes of the volume of output (i e one based on revaluing the value of principal products and the other revaluing gross output of the trade) In most cases this difference was rather small, and we included in our comparison only those trades for which the difference in 1930 was found to be small Moreover we have also satisfied ourselves that in all the trades included the proportion of carry-in and of carry-out in the total value of gross output was small in 1935 (not more than about 5%) Thus although the changes in productivity shown for individual industries are approximate, the margins of error on this account are within reasonable limits

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V INDIVIDUAL INDUSTRY STUDIES

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70 *Works Progress Administration National Research Project:*

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99 Data on hours of work were collected (*a*) in connection with the *Census of Manufactures* for 1909, 1933, 1935, 1937 and 1939, (*b*) by the National Industrial Conference Board (*Wages, Hours and Employment in the United States, 1914-1936*, and later supplementary publications), (*c*) by the U S Bureau of Labor Statistics from 1932 onwards ('Hours and Earnings in the United States, *1932-1940*', *Bulletin* No 697, also the *Handbook of Labor Statistics*, 1941 edition, vol ii, and *Monthly Labor Review*, passim) For the appreciation of these various Inquiries see Fabricant, S , *Employment in Manufacturing, 1899-1939* (see Item 31), Appendix C

100 See also *Statistical Abstract of the United States* (annual), Washington, U S Government Printing Office

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Note. This index includes the principal references only

Abbreviations ff = and the pages following, n = footnote